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Jedi Journal 4

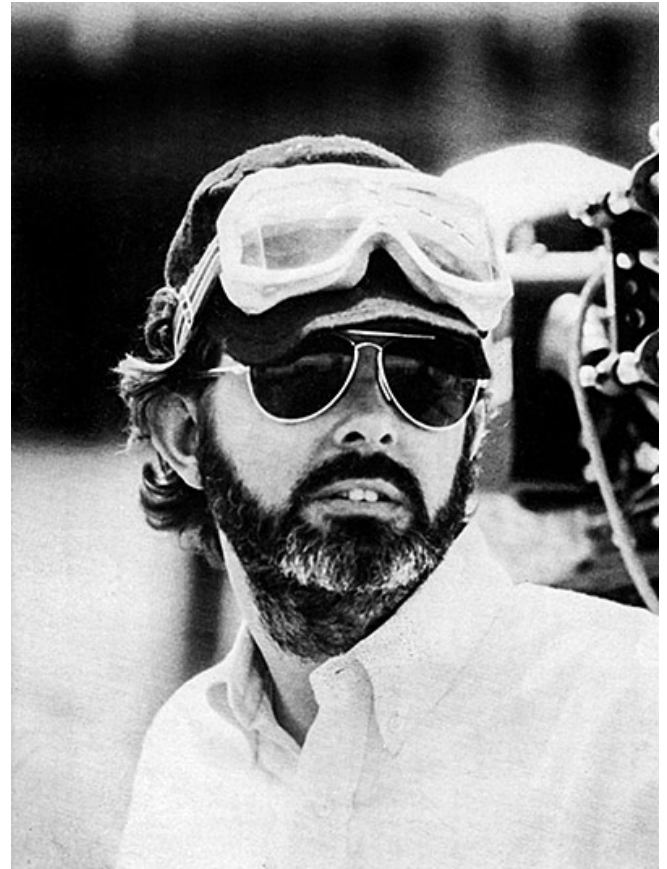
After dazzling audiences worldwide with the first two installments in his *Star Wars* saga, George Lucas set out to surpass even himself with *Return of the Jedi*. Doing so involved not only bringing the middle trilogy to a satisfying and dramatic conclusion, but also mustering forth the considerable capabilities of his off-awarded effects facility—Industrial Light and Magic. Since the latest *Star Wars* entry involved more effects shots—and of greater complexity—than either of its two predecessors, and since the work would be compressed into a somewhat shorter time frame, it was decided to split ILM into three primary effects units. At the helm of each was a seasoned *Star Wars* veteran—Richard Edlund, Dennis Muren and Ken Ralston. As the postproduction effort progressed, each supervisor recorded a month-by-month account of the work as it developed and changed, producing in the process a fascinating account of how a major effects production comes together—the anticipation and planning, the crushing workload, the delights and disappointments. *Edited by Don Shay.*

FRONT COVER — *The Millennium Falcon* races through the new Deathstar.
The Rancor menaces Luke Skywalker in *Return of the Jedi* — BACK COVER.

JEDI JOURNAL

Richard Edlund
Dennis Muren
Ken Ralston

JEDI
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George Lucas, creator of the phenomenal Star Wars series, on location in the Arizona desert for *Return of the Jedi*. At a cost of \$32.5 million — a quarter of which was expended on special effects — Lucas brought the middle third of his proposed nine-part saga to a rousing finale. With three prior Lucasfilm productions already comfortably ranked among the top five boxoffice attractions of all time, and with a seemingly endless file of filmgoers queued up to theaters throughout the land, the outlook for *Jedi*'s success looks positive indeed.

It is unlikely that any film in the history of motion pictures has been more eagerly anticipated than Return of the Jedi. Following on the heels of two phenomenal predecessors, the concluding chapter of George Lucas' middle trilogy in the Star Wars saga was certain to be a sure-fire hit. But Lucas — never one to take his audience for granted — launched into the project with the determination to make it his best yet. After preparing a first draft script from his own story, Lucas collaborated on the final screenplay with Lawrence

Kasdan — whose writing credits include *The Empire Strikes Back* and *Raiders of the Lost Ark*, and who last year debut-directed his own *Body Heat* As with the second *Star Wars* installment, Lucas elected to restrict his subsequent involvement in the independently produced, self-financed production to that of a very active executive producer, enlisting as line producer Howard Kazanjian, who served him in like capacity on *More American Graffiti* and *Raiders of the Lost Ark*. The directorial reins, in turn, were taken up by Richard Marquand, a former British actor and documentary filmmaker, whose feature credits include *The Legacy* and *Eye of the Needle*. Principal photography on the film — originally entitled *Revenge of the Jedi* — began on January 11, 1982. Occupying all nine stages of the EMI Elstree Studios, outside London, the production unit spent twelve weeks working on production designer Norman Reynolds' imposing sets, and then spent an additional eight weeks on location in Arizona and northern California. Meanwhile, the cinemagicians at Lucasfilm's in-house effects facility — *Industrial Light and Magic* — were gearing up for the most ambitious project any of them had ever undertaken.

Having just come off three simultaneous film projects, each handled by a separate organizational unit within the effects facility, a determination was made that *Return of the Jedi* would best be served by retaining the existing tripartite structure. Richard Edlund — a three-time Oscar winner for *Star Wars*, *The Empire Strikes Back* and *Raiders of the Lost Ark*, and effects supervisor on *Poltergeist* — was given principal responsibility for the desert battle around Jabba the Hutt's barge and the climactic rebel attack on the Emperor's new Deathstar. E.T. Oscar winner Dennis Muren — who had also worked on both previous *Star Wars* films, plus *Close Encounters of the Third Kind* and *Dragonslayer* — would handle the scenes of Luke Skywalker's confrontation with the Rancor pit monster, the breakneck speeder-bike chase and the forest battle between the ewoks and the Imperial scout walkers. Ken Ralston — whose *Star Wars* involvement likewise dated back to the first entry, and who had subsequently served on *Dragonslayer* and *Star Trek II* — was given the film's complex and elaborate space battle sequence.

The effects effort was already gearing up more than a year before the film's release...

2 February 1982 — RICHARD EDLUND

Revenge of the Jedi, of course, closes out the middle third of the *Star War* trilogy. George, I think, initially produced the first act in a real exciting way and got everybody really caught up in it Then he gambled in the second act that people would have enough love for *Star Wars* to get them back into the theaters and enjoy *The Empire Strikes Back* just as much, even though it left many things unresolved — which was daring. Some of the critics didn't much like that, but obviously the people forgave it. Now, with the third act, of course, George has to really drive the nail home, and I think *Revenge of the Jedi* is going to do that. Right now, I'm still totally immersed in *Poltergeist*, but I have read the *Jedi* script and in a few weeks I'll be going over to England to supervise some of the effects shooting. The script is very good, and many things are resolved — but George is very secretive and there are certain pages that you know are not the right pages, even though they read very well. So there will be surprises, no doubt, for all of us.

George has a lot of chips riding on this one. He's over in England now working with Richard Marquand, and will probably stay there until the picture is finished shooting. He's very concerned about getting it finished on time and bringing it in on budget — or under budget. He doesn't want to spend \$50 million on this, which you could easily do if you're not real careful. The overall budget for the picture is about \$25 or \$30 million. *Empire* was about \$25 million, so that's not too bad

considering three years' worth of inflation. Fortunately, the dollar is doing a lot better against the pound now, which helps a lot. Our effects budget is about \$8 million, which sounds like a helluva lot of money — and it is — but it cost us, I think, \$6.5 million to do *Empire* three years ago, and this picture has a lot more effects.

We've done five films here at ILM since the last *Star Wars* episode, so we've got some more experience under our belts and some better technology. And we'll be focused together on a single project — though it looks like we'll be split into three separate units. Dennis Muren, Ken Ralston and I will each be heading one, and we'll be working more or less autonomously. Joe Johnston and George Jenson have been drawing storyboards for about six months — hundreds and hundreds of storyboards — drawing and redrawing them as George refines his sequences and changes things around.

As with the other pictures, *Revenge of the Jedi* starts out in space again. This time, the rebels have a great big cruiser of their own and there'll be a need for some grand matte shots there. Then the action opens up as Luke and Leia go back to Tatooine to rescue Han Solo from deep freeze. Location work for that will be done near Yuma, Arizona where Jabba the Hutt's levitating barge is now being built out in the desert, under strictest secrecy — which is no small undertaking in itself. The rationale for that, of course, is that if the word were to get out that the new *Star Wars* movie was being filmed outside Yuma, we'd have people out there pitching their tents on the sand dunes for months. The *Star Wars* fans are a real die-hard breed. We've actually had some of them going through our garbage. At ILM, we now have to shred everything before it goes in the trash because we've found people in our dumpsters going through coffee grounds and stuff just to try and find a few frames of secret film. So we're going to keep our locations secret as much as possible. Of course, as soon as anyone sees a stormtrooper walking around, it'll be all over. We're also doing some location work in northern California, up near the Oregon border. That'll be for another big sequence in the film — a wild battle on a forest planet which serves as an important outpost for the *Empire*. The planet is inhabited by ewoks, which are very small and rotund little furry creatures — almost like little Wookiee-type characters — who live in tree houses and swing around on vines. There'll be midgets and children playing them, and they're very resourceful, even though their technology is sort of on the twine and boobytrap level. Anyway, the ewoks participate in a battle where Luke and Leia and the stormtroopers are involved. The two-legged scout walkers that were seen only briefly in a couple of shots in *Empire* will also be featured — though they're camouflaged, so they'll look a little different. One of them is even going to be built to full size as a set piece. There'll also be a couple of the big walkers just kind of parked there in the forest. Another big effects sequence will be a chase through the redwoods on these sort of flying motorcycles that race along at breakneck speed through the trees. And during this chase, the ewoks try to help Luke and Leia by using relatively crude, but comedically effective, sticks-and-stones methods of thwarting the stormtroopers.

Meanwhile, the *Empire* is building yet another Deathstar, and this one is even bigger and grander than the last one. At the end there'll be a furious space battle and dogfight that takes place in and around the new Deathstar — which will be really interesting to deal with because there'll be a lot of wild flying scenes through girders and partially completed structures.

We're going to have some great new models. There'll be a rebel cruiser this time and a really nice-looking single-wing fighter. It's just a long wing with a cockpit at one end, and then these little winglets that flap down and an engine sort of in the middle, just adjacent to the cockpit — and the cockpit rotates so the thing can fly around. I think that will allow for some really interesting battle maneuvers in terms of compositional geometry. A new fighter is also being introduced — called the A-wing. It's a small, streamlined craft reminiscent of the speeders in *Empire*, and those will be joining the X-wings. Plus the Y-wings are coming back. I never really liked them too much in terms of appearance. The X-wings are much more dynamic-looking — but the Y-wings will be in again. And of course, a lot of little cruisers and shuttles and things. The Deathstar, I think, will be a lot more interesting than the one in the first *Star Wars* — mainly because it's under construction, so we'll be flying down through this half-finished Deathstar which will be a lot more exciting. Plus it will be much bigger. In *Star Wars*, it was really difficult to establish the scale. It was supposed to be miles in diameter, but with a full sphere it was hard to tell. The new one is supposed to be more like *five hundred* miles in diameter, but since we're not dealing with a sphere all the time, we'll be able to establish landmarks and get a better sense of scale. Lots of visual perspective.

And of course, in the desert scenes we'll have Jabba's barge — which is being built full-size, but we'll also be doing some miniature work with it since it has to levitate over the sand and ultimately get blown up.

image

Director Richard Marquand checks out a possible camera angle on stage at England's EMI Elstree Studios.

Then there are also skiffs which, again, are levitating units that hover just over the sand, and they have ear-like rudders on them. We'll be doing some of those in miniature, and there'll also be some full-size ones that we'll be shooting with the actors on our new stage next door. We're initiating that stage right now on *Poltergeist*. In fact, it was absolutely packed with sets the day it was finished. We had five shots going on at once over there. The building itself is quite large, and in addition to the ILM stage, houses our computer graphics team. The stage is

image

Between takes in Jabba's palace, Marquand confers with executive producer George Lucas on an upcoming scene.

thirty feet high, with a forty-foot section in the

image

At Industrial Light and Magic, Lucasfilm's celebrated effects facility, the staggering Jedi workload was divided among three veteran effects supervisors — Richard Edlund (shown here), Dennis Muren and Ken Ralston.

middle and a pit that's five feet deep. We'd wanted to go fifteen, but the area we're in is built on land fill and it would have filled up with water. Right now we're building a big fluorescent blue screen to go in there — thirty-six feet wide and twenty-three feet high. That'll see a lot of use on *Revenge*.

We'll also have a lot of new monsters in this one. There's a real swashbuckling scene in the desert where Luke has to "walk the plank" over the Sarlacc pit — which is a big hole in the sand with a monster inside, and if anyone falls in, these giant teeth come in and grab him. That's going to be built full-size. There's also a fight between Luke and the Rancor pit monster — a giant creature that's kept captive in Jabba's palace. Then there's Jabba himself, and his crusty crew that are almost all monsters of one sort or another. We had a "monster shop" going for about a year turning out these elaborate monster suits — a million dollars worth of monsters. Phil Tippett was in charge of that operation, and it was set up — with much help by Stuart Ziff and some others — as a shop

within itself. They didn't rely too much on ILM. In fact, they moved completely out of our building and into a bay across the parking lot; so we didn't even see too much of them. They're over in England now working with the main unit.

One of the main things I've tried to do up here is sort of be an architect of the whole photographic system, and set up equipment which is flexible and produces material of high quality. It's been a gradual project, but I think we've really closed in on it in recent months. Just in the area of cameras, we've come a long way. One of the problems we had with *Star Wars*, in terms of the space battle sequence, was that essentially we had only two cameras — plus a third one occasionally, the high-speed camera. We had to shoot so many shots a day that it didn't allow us the luxury of leaving a camera set up on a situation for very long. We had to set up, shoot a black-and-white test, then shoot the color, break the setup and move onto the next one. Even on *Empire*, we still had essentially only two tracking systems. Now we have three *large* tracking systems — and we're soon to have four — plus a lot of extra cameras that can be set up for backgrounds and for special shots that require extra massaging. As a result, now we're more likely to leave a camera set up and work longer on a shot to get it better. The proficiency of our cameramen has increased, too — not only from within, but from without. When we first started out, we were the only ones doing this kind of work. Now, all of a sudden, we find cameramen coming around who know their way around motion control equipment and can get checked out on ours in a couple of days. And they have ideas and ways of working that stem from their own particular backgrounds, and everything starts to comingle — which is good, because every project we do is like another graduate course in effects work and we're all kind of helping each other and learning all the time. An effects facility is like a Stradivarius, in a way. Once you've come up with a design and refined it, and experimented with it so you know it sounds good — then you've got to learn how to play it real well, because people like George Lucas and Steven Spielberg walk in with demanding “scores.”

Most of the shots on *Empire* were composited on our quad printer that we built especially for the project. It was running at about ninety-five percent of its designed capability on *Empire* and as with any fancy technology, the last five percent is the most agonizing. Through *Raiders*, and then through *Poltergeist* and *Star Trek* which are now being composited, that printer is totally up to speed — and it's really “trick,” so to speak. It has the kind of positionable repeatability that we wanted — which is on the order of one and two-tenths of a thousandth of an inch — and you can be working on one element and walk away from it knowing that it's going to finish printing that element and automatically go back to where you wanted it. On our earlier films, we'd have to farm out a small portion of our opticals — mainly those that were done in 4-perf format. On *Revenge*, we'll probably be putting all the opticals together in-house, since we now have two 4-perf printers in the facility — one's a company-owned printer, and one's mine. In fact, Ken Smith is using that 4-perf capability right now to composite *E.T.*

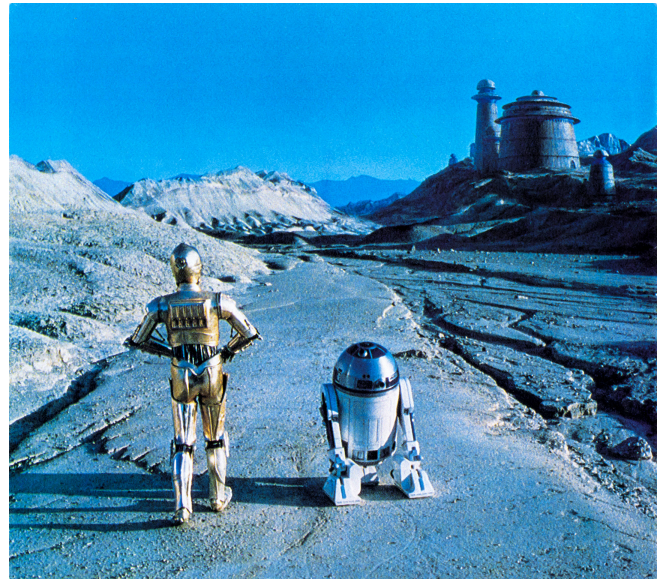
We've completely revamped our motion control system since moving into this facility. Not one of the “ancient” systems is still in use — the last of them was retired about two months ago and replaced with a new one. The motion control on our *Empire* camera system has been refined considerably. Not knowingly, we went off half-cocked on that project, only to find a nest of problems, which we've managed to sort out over a period of time. We've now rebuilt the pan-tilt head with high-resolution encoders and counterbalances and all sorts of things to help insure

precise repeatability. One of the critical areas we found was the entrance pupil of the lens — the apparent pupil position where the rays cross in the lens. That point, which is like the pupil of the eye, has to be exactly at the right position in terms of where you're panning and tilting from. If it's off by a few thousandths of an inch, it's not going to work — so it has to be very precisely aligned. On the first system we built, we started by modifying an existing head; and we tried all kinds of adjustments, but it just wasn't working. With very dark backgrounds, you might have been able to get by with it — or if you were trying to make a repeat move on something that wasn't attached to anything. Otherwise, forget it. We were batting our heads against the wall wondering what the problem was. It turns out that the pan and tilt were not even on the same axis. We'd assumed they would be, but they weren't. In fact, they were off by about three-eighths of an inch! So those are the kinds of things we have to deal with.

Our technological development seems to happen in a semi-scientific way. Most of the guys working in our facility are artists or practitioners first and scientists second. In other words, we start with an idea for a particular shot and then we try to get scientific about how we're going to go about doing it. And our resources are limited. Even though the films make a great deal of money, only a certain amount of that filters back to ILM. After all, George has a lot of other projects on-going that he wants to spend money on. So we have to kind of feel our way through these things. Generally, I think the way innovation happens around here is that an idea comes up and you say: "Let's build this." So you build it; but in the process of building it, you discover that it doesn't quite work the way you want it to, and so you have to rebuild it. But you had to build it in the first place to find out why you had to rebuild it. That's sort of the way our master system has developed.

We have a field operable motion control system that we've been working on for quite a while that was probably about ninety percent "tricked out" on *Raiders*. We're using it for a couple of scenes in *Poltergeist* and we're probably at about ninety-eight percent. *Tor Revenge*, I think we'll be able to use it to put a miniature on the ground in a scene that's been shot somewhere else — with full pan and tilt. That's a very difficult thing to do — there are so many subtleties involved. As far as I know, nobody's ever really done that; but I think we're ready to get into it on *Revenge*. We have the tools to do that now.

The Dykstraflex is still intact, and we have another camera system — the Technirama — that's been completely rebuilt. It has a new follow-focus, tilts ninety degrees on its side and forty-five the other way, and is on a great big 250-pound gear head on top of a boom arm which sits on a twenty-foot track. It looks like something from outer space. That's just on the verge of being finished now, and



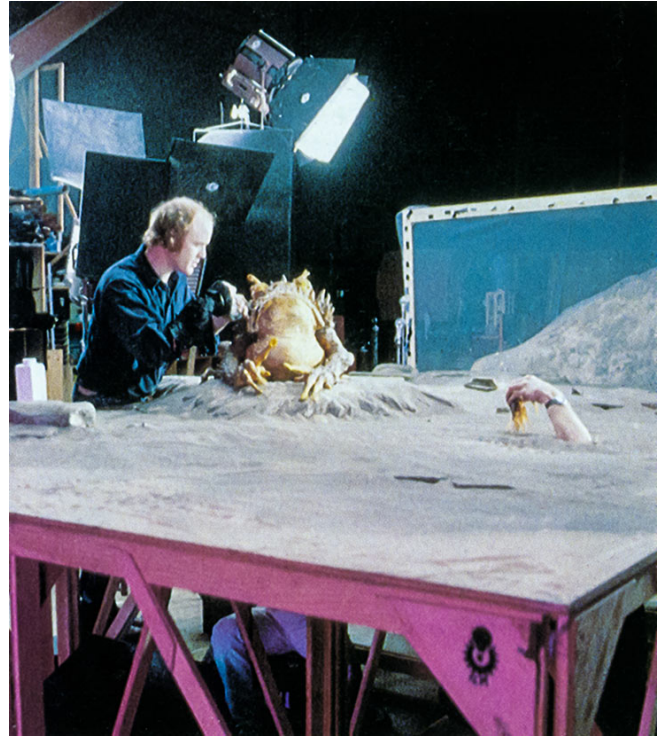
As the film opens, Luke Skywalker and colleagues return to Tatooine and converge on the desert stronghold of Jabba the Hutt to free Han Solo, who has been carbonized and placed on display. Bearing a message of warning from Luke, C-3PO and R2-D2 take the frontal approach. The palace — a Michael Pangrazio matte painting — was combined, on ILM's new Automatte system, with live-action footage shot in Arizona.

it'll be a high-speed servo-drive system capable of going from one end of the track to the other in maybe five seconds — including a slow-in and slow-out—so you can do very fast moves. In contrast, most of the motion control equipment around Hollywood is set up with stepper motors, and moves very slowly because you're normally only shooting about one frame a second. The Rama camera will run 42 frames a second in motion control, so we'll be able to do shots involving actors or smoke or things — any kind of shot where 42 frames a second would be sufficient.

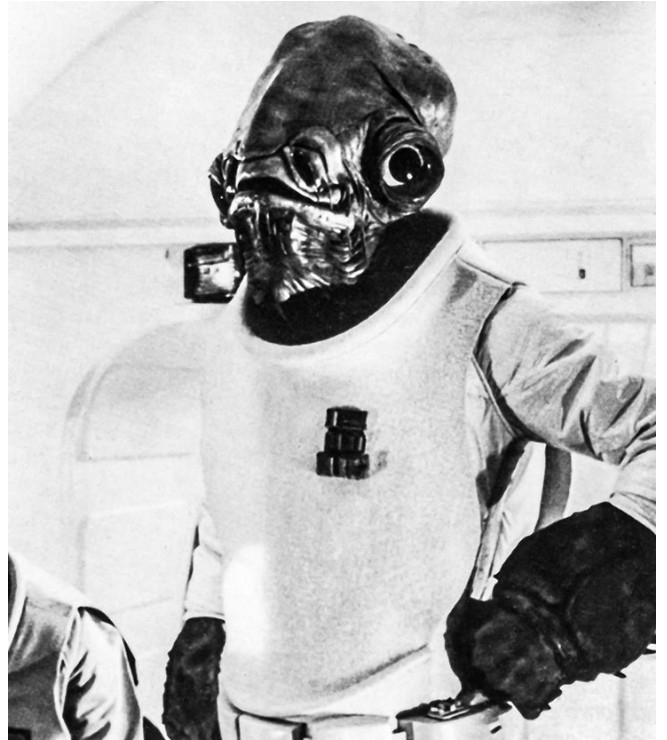
Probably our biggest unveiling, technically, on *Revenge* will be our new matte camera engineered by Mike Bolles and built by Gene Whiteman with a George Randle camera. It's something we've been building for a couple years, and it's a real locomotive — enormous, but extremely precise. It's a multiplane camera with two painting carriages that have x-y-and-z movement capability, and a third that is just locked off. That's usually enough to give you plenty of flexibility; but if you need more, it's relatively easy to hang something together on a pipe-clamp. The camera can rotate in x-y-and-z, and it has a sixteen-channel motion control system attached to it. As a result, we'll be able to do very complex moves with separations, and do three passes or five passes and they'll all repeat right on the money. It'll also enable us to shoot in either VistaVision or normal 35mm format, because it's an 8-perf *and* a 4-perf camera. It also has probably the finest anamorphic lens in existence. David Grafton designed it for us. It's a four-inch focal length lens, and it's not based on the same principle that Panavision uses or CinemaScope used or any of the other anamorphics use now. It's a completely different way to make an anamorphic lens, and it's the best there is. It's huge — about eighteen inches long and nine inches square — but it comes off the camera very simply with just four bolts and then you can quickly put this dinky little spherical lens on in its place that's sharp as a tack and allows you to shoot VistaVision or 4-perf. It can also focus down to about a dollar-bill size, so it can be used for very high-quality anamorphic animation. So really, all the formats shy of 70mm are capable on the system. And on a technical quality basis, you can't do much better. Of course, if you were doing the matte painting as an original negative held-take, then the quality would probably be better, because nothing can be better than original negative. But on the other hand, you're very limited by original negative, because it all has to be right there in the camera. You're at the mercy of which take is the best one, because you don't even see it until it's been put together. Plus you're pretty much limited to a locked-off shot, unless you have your act so together that you're not apparently holding up production while you twiddle around with knobs and dials to get some kind of pan and tilt into your plate. It's very complicated and very expensive to fool around very much on a production shot — and very hard to justify in terms of monetary cost. So you've got a little bit of a pan on a shot, or a little bit of tilt — so what? And yet, on the other hand, that's often what *makes* it. A little movement always adds plausibility to a painted matte shot.

One of the things I'm going to try to do when I get to England is to expand the scope of some of the matte shots and get some really enormous vistas. Over in England, they like to *build* everything. They've got master carpenters and plasterers over there, and if they have a fantastic set, they go ahead and build it — the whole damn thing. But they're still limited by the size of the soundstage. Even if they fill the big *Star Wars* stage at EMI Elstree, we could still make the shot ten times bigger if we use the camera in the right way. It's like the scene in *The Day the Earth Stood Still* where the ship comes into Washington D.C. You kind of would like to have seen the whole capital in that shot — tanks and guns and thousands of Marines in battle gear. Instead, it's this medium shot with two

tanks and one jeep full of guys. Those big expansive shots are the kinds of things you can do with a well-executed matte painting. So when the Emperor comes on board the Deathstar, instead of seeing something that could be shot in the corner of a stage, we want to show something that would have to be shot from a helicopter several miles away — something that's going to demonstrate clearly the stunning breadth of the dark side of the Force. So that's what I'm going to try to do in England — to make sure that we get some good plate material that will allow us the flexibility to do that.



For incorporation into another desert matte painting, creature designer Phil Tippett rigged a puppetized alien to snatch its feathered prey — being held from below by another ILM technician — with a long, darting tongue.



Admiral Ackbar — one of many new aliens designed and built by the ILM “monster shop” under Tippett’s supervision — directs his aerial armada from the bridge of the rebel cruiser.



Rattle axe in hand, a Gamorrean guard stands watch in Jabba's throne room.

We also have a new system of shooting what we call “videomatics” — which replace the animatics we used to use. Originally we started out shooting storyboards, just to have something to cut into the film while the effects work was in progress. Then we started adding a little bit of animation to the storyboards — rough line drawings animated on fours or eights just to get the extremes of the shot. Those would often be in the film for months, or a year sometimes, until we had a comp or a temp to cut in. This time we’ve set up one of Petro Vlahos’ UltiMatte video systems which will enable the cameraman who’s doing the sequence to shoot his own chroma key animatics and see what the dynamic problems and speed problems are going to be. It’s all being done on a very perfunctory level — guys in blue suits running around with models mounted on rods or wires. Then we’ll pull tape-to-film transfers and cut it into the workprint, just to get an idea of the pacing. The bike chase through the trees has already been shot in video form, using some funky miniature sets and prototype models, and the technique looks very promising.

We may be using our computer graphics team to do the lasers and the light sabers that we’ve always done with traditional rotoscope and animation camera techniques. It may be cost effective this time. Then again, maybe not. In fact, it probably isn’t at this point — but at some point it *will* be, and you have to stretch out. George is very supportive of that approach. Based on some tests that Triple-I (Information International) did for us on *Empire*, George realized that computer graphics was just around the corner from being able to put thousands of X-wings into the sky from a single program. And the thing is, if you don’t jump on the bandwagon and start researching these areas, somebody else is going to do it; and five years from now you’re going to be way behind. But if you channel some funds into it and start developing it, you’re always going to be two steps ahead of everyone else who didn’t. (The computer graphics team’s contribution to *Jedi* was ultimately limited to the generation of a few tactical displays — most notably a three-dimensional vector representation of the new Deathstar in orbit over Endor.)

All this is going to become a lot more clear once we get our current three projects out of the shop and start devoting our full energies to *Revenge*. I’ll still be involved with *Poltergeist* for probably two more months, or thereabouts — maybe even three. So I’m trying to finish that up and meanwhile try to get my head somewhat in gear for the next big one. Most of my ideas at this point are still rather wispy. I do know that what we’re going to do on *Revenge* will really show our development as



Jabba, a massive mound of foam latex “flesh,” required numerous effects technicians to actuate his various functions.

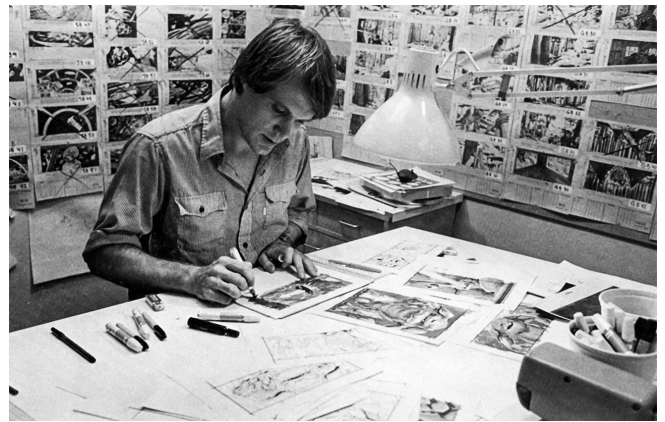


Pressed into service aboard Jabba’s sail barge, C-3PO seems less than at ease amidst an odd assortment of intergalactic revelers.

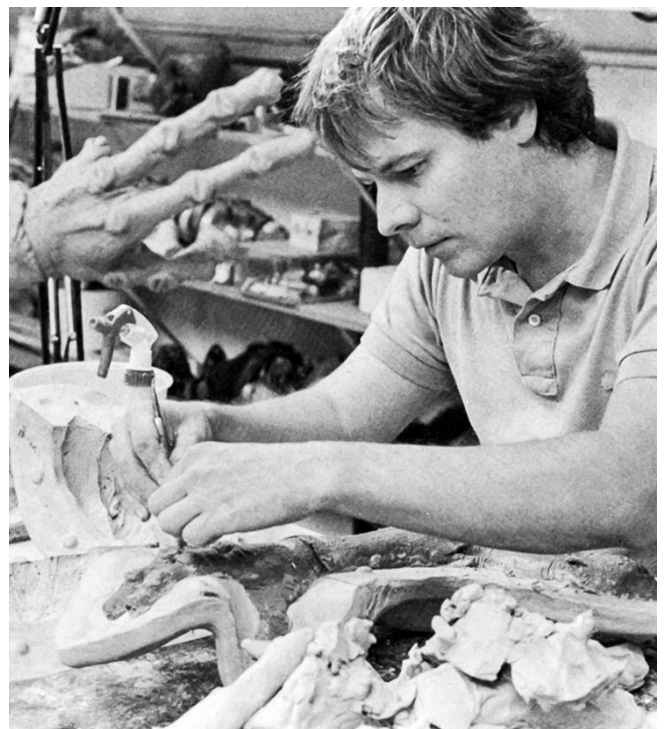
a company, from *Star Wars* to *Empire*, through *Raiders* and the pictures we're working on now, right on into *Revenge of the Jedi* — which is sort of the main reason that we're together in the first place, as a group. We've taken on these other pictures to keep the facility together and to refine and hone our talents — but the real *raison d'être* is *Star Wars*. A lot of what we'll be doing will be similar to what we've done before; but what we'll be able to do on this one, I think, is to really refine and further take the edge off the effects — which I would say still have kind of an air of artificiality. And to get past that, these days, is really asking a lot. Your audience is so sophisticated, visually, that you have to be very canny to come off with a way of fooling them. And in the great measure, George is the one who's going to pull that off, because he knows just how to use the effects. He knows when he can get away with a weak shot because the action's going to carry it; and he knows when the shot's got to be really good and pay off because it's there all by itself. And with George there in dailies every day — as I'm sure he will be — we'll have the benefit of his vision.

1 August 1982 — RICHARD EDLUND

Right now we have six crews shooting elements — three day crews and three night crews. Dennis and Ken and I all have our individual units going, but we have dailies twice a day and we all see the same dailies and talk about the shots. We've printed out how much work there was on the first show and how much on the second, and there's actually *more* work to be done on *Revenge* than on either of the others — both in terms of shots and elements. The whole project I think, is going to have about 450 shots; and for the most part, there'll be many more elements per shot in this picture than in the last one. Whereas we have about a third the amount of time. Having *Poltergeist* and *E.T.* and *Star Trek* in the shop took a lot of our time and resources; and as a result, we wound up with less time than we all hoped we would have for *Revenge of the Jedi*. So I have a feeling we're all going to be a lot more burned out at the end of this one — but we're not all down in the dumps about it and I don't think it's going to impact much on the quality of our work. For one thing, we've all gotten a lot better at what we do; and space stuff, for us, is something we can almost do falling off a log. Plus we don't have to build the studio as we did on *Empire*. On *Empire*, I had to hire a lot of people and bring them up here from Los Angeles, so we were starting fresh with only about six or eight members of the original *Star Wars* crew. Since then, we've been able to retain most of our



Effects art director Joe Johnston renders storyboard drawings for Luke's battle with the Rancor pit monster.



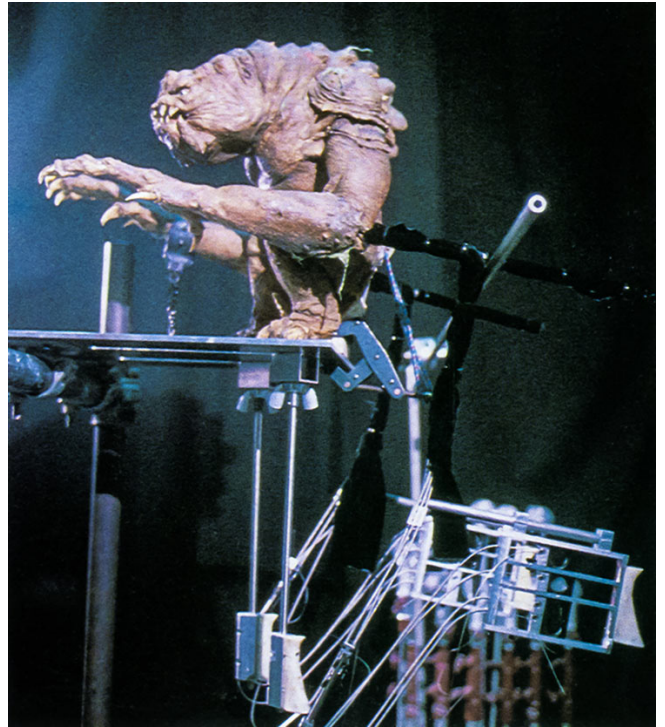
people. We have three very experienced supervisors; we have more equipment than we've ever had before; and the departments are running more autonomously now. Everybody seems to be functioning with less guidance than was needed previously. We've also come up with certain shortcuts and ways of doing things that will effectively give us more hours per day in just about every department.

Phil Tippett has designed a mechanism by which the creature can be moved. It's a cool mirror to help reduce heat by reflecting out the infrared radiation.

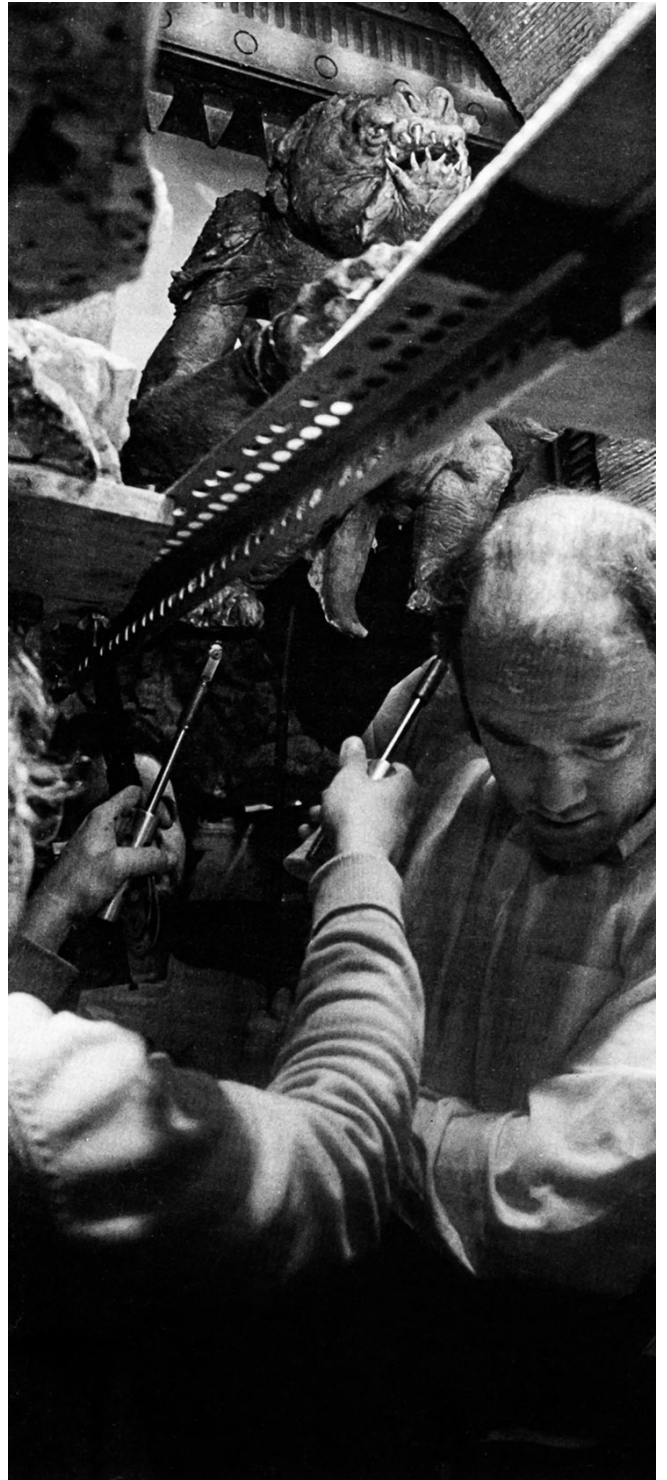
At this point, we have five completed motion control systems. We've more or less gotten rid of every piece of equipment that we've had lying around here from the first picture. The original motion control equipment has been retired — all the electronic material — so we have all new stuff, and Jerry Jeffress and Kris Brown have come up with some new electronics and software modification programs that all the cameramen have been getting into, so that if we have a shot with multiple elements in it, we can now modify programs and smooth programs and speed up the whole process by the use of this new technology.



Articulation of the Rancor creature was achieved manually from beneath the elevated set. Head and body movements were produced by Phil Tippett, whose hand fit inside the puppet.



Arm movements were created by Tom St. Amand via rod mechanisms extending out and down from the elbows. Additional rods, connected to the feet, were manipulated by Dave Sosalla.



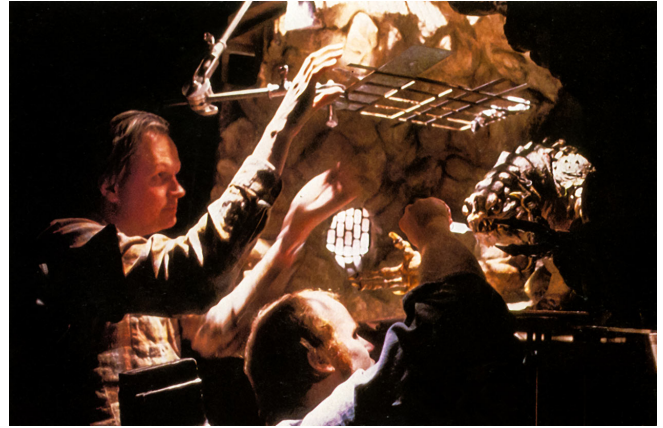
Hunched under the set, Sosalla, St. Amand and Tippett activate the Rancor.

For the moment, the animation department is scaled down — at least from where it was on *Poltergeist* — but it will be cranking up again as we get further along. There's always a need for a lot of sweetening work. The matte department is in full swing, and they're going pretty much on their own, kicking in some ideas here and there. I was in England for two-and-a-half weeks in February, and one of my main concerns was supervising the plate photography for some of the really expansive matte paintings.

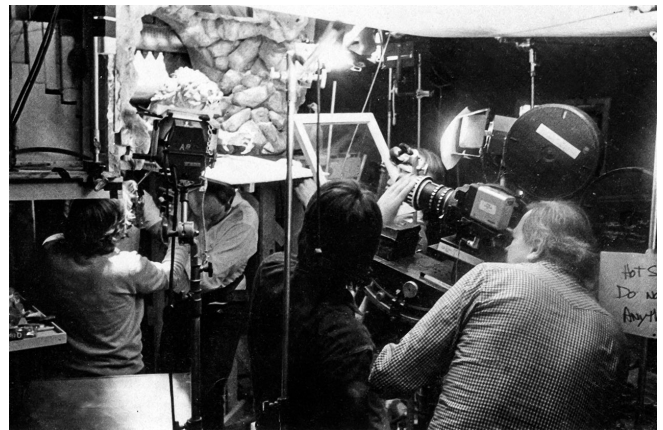
Norman Reynolds built a set for the landing bay of the Deathstar, which was just *immense*. In fact, it filled the *Star Wars* stage, which is the biggest stage in England. But with matte paintings, we're going to make it seem a great deal larger. After shooting the Emperor's arrival and another shot of Vader's arrival, the whole set was then converted into a rebel bay and shot with a different floor. So these are the kinds of things the matte department is working on, and they already have a few matte shots nearing completion.

Our big matte camera is doing really well, and one of the things that we're starting to get into is foreground miniatures, where we'll have a matte painting and then a foreground miniature being shot with it. We haven't done that before, and it really helps when you're doing moves on a painting. For distant subjects, you can multiplane your painting and the effect is fine; but for the closer things, it's best to have miniatures rather than a moving painting, because then — as you move across the frame — you get perspective changes going on in the foreground that really help, but that wouldn't be noticeable in the background. For example, in the Deathstar docking bay we're using foreground miniatures of some gantries and guns and other equipment. These will be shot right along with the painting, but on separate light passes; and then, to sweeten the shot, we'll be doing extra passes to put some really tiny guys walking around and welding and so on — those will be rear-projected in. So the matte department is going to be a major force on this picture, with Mike Pangrazio, our chief matte artist, working with Chris Evans and Frank Ordaz, and then matte cameraman Neil Krepela getting the most out of the paintings by wielding the new Automatte camera, assisted by Craig Barron.

Another thing I was involved with over in England was the Emperor's throne room. That was a huge set with a lot of big windows in it. The window areas, of course, would be matted in, but doing it bluescreen would have been laborious and rather difficult in terms of blue spill off shiny props and that sort of thing. So I recommended that we make the window areas black and then simply



Effects supervisor Dennis Muren adjusts the shadow grating while Tippet applies goo to the inside of the creature's mouth.

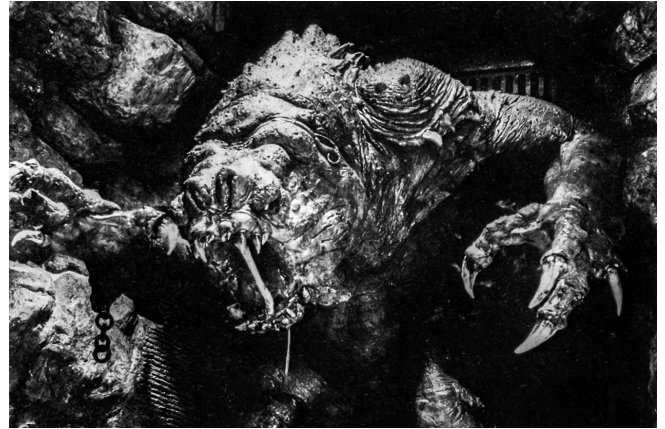


Muren records a take — incorporating a sense of aerial perspective by shooting through a pane of glass angled to reflect a sheet of white masonite mounted over the set.

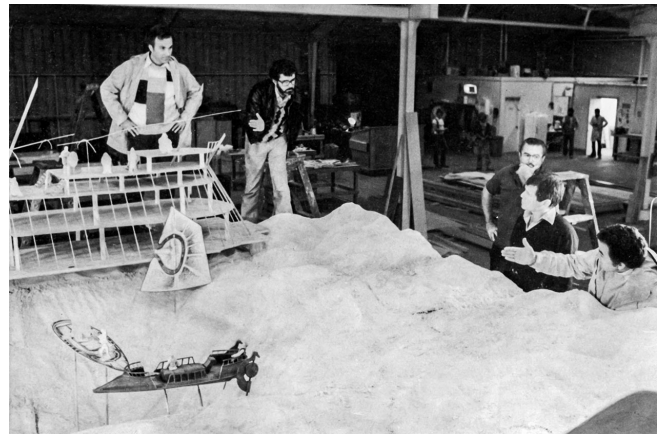
rotoscope the actors as they walked across. We did a lot of other bluescreen work though — the interior of Jabba's barge, shots of the rebel cruiser bridge — and almost all of it was done with the rear-light method this time. That's the technique we've used all along on our model photography, and we feel it really provides the best traveling mattes. Over in England, we had the 32x-20-foot fluorescent screen that had been built for *Dragonslayer*, and we also built another 12x20-foot one. So basically, my job over there was just to get with the crew and make sure they didn't commit any cardinal sins from an ILM effects point of view.

We also did some live-action bluescreen shooting back here — on our stage next door — after the location work in Crescent City and Yuma. The first unit was here for about a week, and I spent a couple of days with them getting some plates for the desert battle sequence at the beginning of the picture where Han Solo gets decarbonized and rescued. We had a full-size skiff — eighteen feet long — up on pylons, and then pinned some large fluorescent coverings over the pylons so we could make them blue as well. Then we had Luke and Han and the others on the skiff, and lit it with two or three thousand foot-candles to look like daylight. We didn't actually move the skiff, whatever movements we wanted, we got by moving the camera. Most of the shots just have a little bit of floating action, but there's one where the skiff actually comes into the shot with a panning background — that'll be the trickiest shot. That sequence hasn't been finally cut, so we're not actually putting any shots together yet, but Bruce Nicholson and his optical people did a trial composite on one of them and it came out pretty good. It really looks like they're out there in the sun. We'll also be doing some skiff shots with a bunch of Jabba's monsters, which are also involved in the sequence. There'll probably be ten or twelve shots in all using that same basic technique. Then we'll have some straight miniatures for the longer shots — and for the finale, Thaine Morris will be doing some of his great pyrotechnic work to blow up the whole barge.

We're in the process now of working out some new techniques for blowing up miniatures. One of the things we're planning to do this time in the space battle is to actually blow some of the ships apart with shotguns — kind of like shooting skeet. When you blow up a clay target, it just comes apart totally; and it also goes in the right direction. It's not a totally new technique with us. We used



The Rancor roars in fury when Luke wedges the bone of a previous victim in the creature's mouth. To keep the skin moist and lifelike, the puppet was spritzed with water before each take.



Using a rough mockup for visual reference, producer Howard Kazanjian, George Lucas, Richard Marquand and production designer Norman Reynolds work out camera angles and preproduction choreography for the desert battle.

shotguns to help blow the exploding head apart in *Raiders*, and we used them in *Poltergeist* to accentuate the imploding house. But this will be the first time we try it on miniatures in space. [Although preliminary tests were encouraging, the “shotgun” technique ended up not being used since the shots earmarked for that approach were ultimately cut from the picture.)

Right now, we stand in the toe of the curve, so to speak. Out of 450 shots, we’ve got maybe one or two finals at this point — one of which is a shot of the photon torpedo exiting the Deathstar that we took from the first show and recomposited. So we’ve got a ways to go. I’m involved primarily in the desert sequence with Jabba the Hutt’s barge and the final rebel attack on the Death-star. Ken Ralston and his crew are doing the dogfight sequence, which involves *enormous* numbers of ships fighting it out in space. Ken has been on that camera *all* the time — for years now, it seems — and he and his crew have the ability to really crank that stuff out. In my case, it’s a little more difficult to get back into space pictures, because I haven’t *done* them for a while. I had nothing to do with *Star Trek*. I worked on *Raiders* and *Poltergeist* for the last year and a half or more. My crews are not space-oriented, either, so I’m having to reorient myself and at the same time kind of break them in.

Meanwhile, Dennis Muren is doing most of the forest stuff— including the high-speed chase on the wheel-less speeder-bikes. Originally, the idea had been to build the whole forest in miniature and shoot it motion control — sort of like the work in *E.T.* — but it soon turned out that that would have been incredibly difficult and very costly. For one thing, such a miniature would have to be built to a pretty large scale, just so you could get close enough to it and still hold focus. As a result, it would have involved a lot of model shop time to build it, and then a lot of stage space and time to light and shoot it. So the idea came up to actually shoot the backgrounds “live” in the forest. We got a VistaVision butterfly camera from Paramount that was really quite light — about 22 or 23 pounds, something like that — and that included battery pack and film and a device to enable the camera to roll. Anyway, it was about as light as anything you could find, even in 4-perf. Gene Whiteman took that camera, lightened it, motorized it, and mounted it on Garrett Brown’s Steadicam unit and soon Garrett was treading through the forest up around Crescent City, walking very carefully, keeping the camera level and shooting about one frame per second to get the background plates Dennis would need for the high-speed chase.

The speeder-bikes themselves will be done in miniature, and the model shop guys have come up with this really beautiful little machine. The bikes will have miniature riders, too. Based on some things that were learned on the bike sequence in *E.T.*, Dennis and Phil Tippett have come up with a way of puppetizing the miniatures so they can be shot at high-speed instead of stop-motion. One of the most difficult things in stop-motion has always been to animate cloth moving. In most cases, the whole problem is just avoided. But with this system, the riders can have costumes made out of real cloth that can be buffeted about at the mercy of real wind. The bike and rider are controlled by a rod-type arrangement, with wires to help, and the operators can control the whole thing manually during the shot. So it’s even better than go-motion in some respects, because instead of shooting one frame per second, they can shoot at 48 frames per second and the wind will rustle through the material they’re wearing just like real clothing. It looks fantastic — and very real. Dennis and his crew will be using some go-motion, too — for the forest battle scenes involving the chickenwalkers.

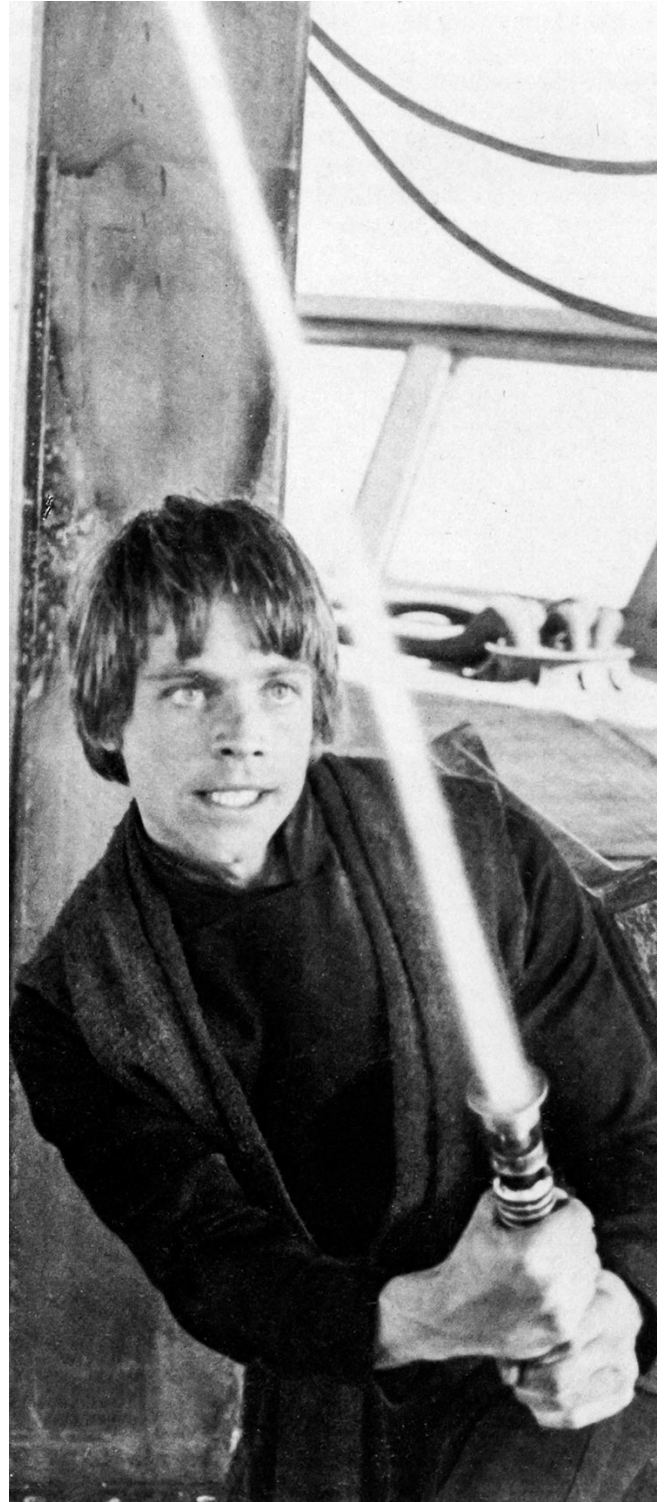
If I had to sum it up right now, I'd probably say we're in a state of...well, "shock" might not be the right word, but there's a *great* deal of work to be done and I think we're all finding that it's not turning out to be quite as cut and dried as we thought it would be. Things *are* more cut and dried than they were on *Empire*, to the extent that we don't have to build a studio from scratch and our organization is pretty well established. But the workload is just staggering, and I don't think any of us realized how really burned out we were after the last three pictures. Some of the departments, like optical and animation, were able to wind down a bit — but some of our other people haven't had a chance to have any time off. At the present, we have three motion control systems going, with crews that come in about six-thirty or seven in the morning and shoot until six at night. Then we have crews that come in at night and work until three or four o'clock in the morning. So we have six motion control crews working almost around the clock, plus we have a few spurious shots going on as extra setups. We're still split up into three basic sections, where Dennis has his sequences and Ken has his sequences and I have mine.

Ken's space battle is going to be quite spectacular. In *Star Wars*, the battle sequence had only a half dozen ships, essentially, that we were dealing with. The way it was cut together made it *seem* like more, but that's really all there were. In *Revenge*, there are literally *hundreds* of them together in some scenes — dozens and dozens of star destroyers, each with a little battle going on around it. In some ways, it's similar to the asteroid sequence in *Empire* where we had lots and lots of elements, including a lot of separately photographed asteroids and things like that. With *Revenge*, we have as many ships as we had asteroids in *Empire* — but it's a lot more complex to shoot ships than it is to shoot asteroids. I'm sure that some of those shots will be more complicated than any that have ever been done before in terms of numbers of elements and complexity of action within any given take. In fact, until it's practical to computerize ships and put thousands of them into a shot, we'll probably hold the record for some time.

My sequences don't have anywhere near that number of elements to deal with, but they're every bit as complex in a lot of ways. The rebel attack on the Deathstar will have the *Falcon* and about six rebel fighters — a couple of X-wings, a Y-wing, and a couple of the new A-wings — flying precariously through tunnels *inside* the Deathstar on the way to the central reactor chamber where they have to drop the big one again to start a chain reaction that will blow up the whole works. And, of course, they're being chased by a half dozen interceptors and TIE-ships. So we're dealing with a bunch of ships flying through very restricted areas with maybe twenty-five or thirty real feet to move around in. Steve Gawley is building all the tunnels now, and he's doing just an incredible job. By the time we finish, he'll have built a hundred yards of tunnel — all detailed and lit. The tunnel footage will be used as background plates, and just the problems of programming moves through these tunnels in the first place is very tedious and complicated.

Even though a lot of what we're doing is reapplying what we've done before in terms of shooting models and hiding mounting rods and dealing with those rudimentary types of problems, I think new situations always foster new techniques. We're getting into some really interesting shots in terms of composition and movement — getting away from the old "pan from point A to point B" type of thing, and into some really real-looking shots. You can always set up a sequence and shoot each shot as a perfect move and all that. But real-life action scenes aren't always that perfect. Take

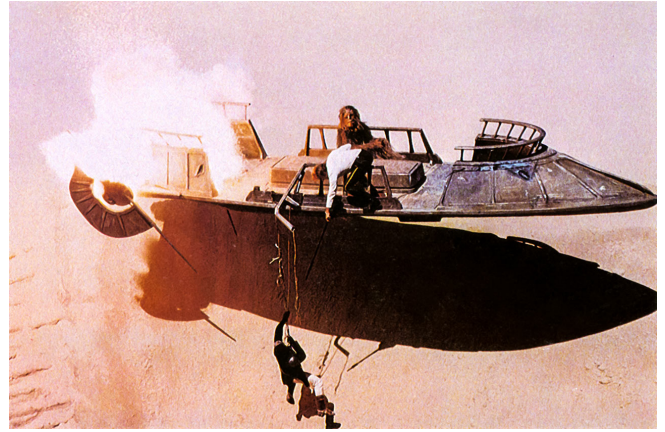
Bullitt or *Road Warrior* or *Raiders*. There's always the random factor that makes it extra interesting, and that's what we're trying to build into our miniature shots.



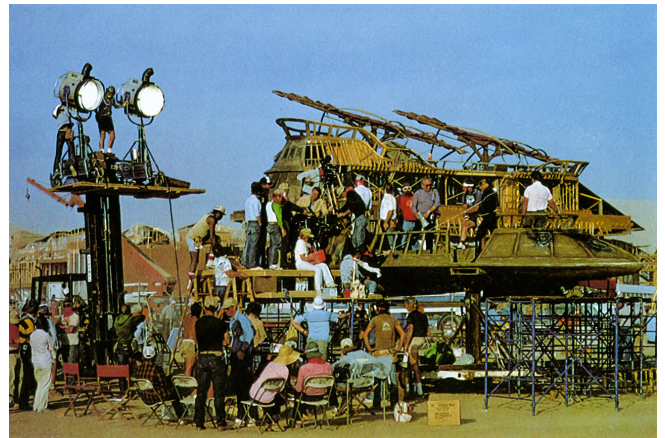
Lightsaber in hand, Luke leads the escape from Jabba's barge. Although computer animation was at first considered for generating the shimmering blades, the more traditional rotoscope technique perfected in the earlier two films was ultimately re-employed.

We have, I think, the ultimate motion control system now. Jerry Jeffress and Kris Brown have come up with just the most dynamic, malleable system anybody around here can imagine. We're still programming basically by joystick — dealing with a lot of shooting-from-the-hip trigonometry — situations where you *could* probably plot these moves out mathematically, but if you did, it would probably take three times as long and wouldn't be half as interesting. But we now have a smoothing and modification program that Kris has come up with that has everybody parading up to this Hewlett-Packard unit that enables you to graph the move you've just joysticked and look at it in relation to the RAR that you've shot — the black-and-white move test. By seeing graphically how the pan works — or the track works, or any of the axes work — in relation to what's on the Moviola, we're then able to apply Kris' modification program to smooth out lumps, add lumps where we need them, compress the program, shift information within the move to get it to work, things like that. And it's saved us. Without it, we wouldn't be able to do this; it would just take too long.

One of the most crucial aspects of the rebel attack on the Deathstar is maintaining relationships. This problem probably features in the dreams of Bill Neil, who is shooting the tunnels, and Mike McAlister, who is shooting most of the ships. Whenever you get involved in architecture and have to deal with ships flying at certain speeds and with tunnels going by at certain speeds, you have to be able to cut from shot to shot and maintain all these key scale relationships, even though the models themselves are often *different* scales. Our standard X-wing, for instance, is about eighteen inches long; but we now have a four-foot X-wing for doing certain shots and getting closer to it. Regardless of the *model* size, however, the X-wing has to look in proper scale to a two-foot *Millennium Falcon*, or to an A-wing which is actually half the size of an X-wing but is *supposed* to be bigger. Scale has always been a problem with the *Star Wars* series anyway, because you're dealing with vehicles that nobody's actually seen before — or, in the case of the Deathstar, with conceptual architecture that doesn't even exist — and there's no way you can relate to it as being as big as the Coliseum or only as big as a liquor store. So you have to maintain certain norms within the sequence and keep track of things like speed, so that when you deviate from that for an effect, it *plays* that way and people don't get lost or not know how big something is or how fast it's moving. You'd think that there'd be a mathematical relationship between size and speed that we



Under fire from the barge, Han Solo and Chewbacca try to rescue Lando Calrissian as he dangles perilously over the Sarlacc pit.



In the Arizona desert, Richard Marquand's first unit prepares for a shot on board one of the levitating skiffs. The full-size barge, constructed on location, looms in the background.

could program into a computer to deal with this problem; but more often than not, it's just too subjective for that. We do end up doing a certain amount of schoolboy math in our heads, but usually it goes well beyond that. We have to keep our X-wing, for example, looking like it's a certain size and going at a certain speed; but oftentimes we have to *play* with that in subtle ways in order to get it — to give ourselves more space to do something without betraying the size relationships that we've established in previous shots.

We're continuing to work on the desert battle. We had our big session with Mark and Harrison and Billy Dee, right after the production finished up in Crescent City. I had two days with them on the set, shooting the full-size skiff we had in front of our big blue screen. Since then, we did kind of a more elaborate skiff shot with a bunch of Phil Tippett's full-size monsters on it, where their skiff kind of skids into the frame shooting at the other one. You have to have a few shots like that in the picture to establish the fact that these guys are actually levitating, to make it believable. The skiff was basically stationary, so we had to move our camera on a big crane to simulate the movement of the skiff, and pan to simulate its traveling across the frame. The blue screen we have on our stage is thirty-six feet wide by twenty-four feet high, and naturally we ended up using every inch of it. Whenever we get something, we always wind up having to push it to its absolute limits. If the screen was *fifty* feet, it'd probably be the same situation and we'd still have to roto a few frames where we went off the edge. Anyway, we did a black-and-white precomp on that, and the shot works really well. So we have one main shot where the skiff is actually moving along and changing perspective and those kinds of things, as well as the more locked-off shots we did with the principal actors.

For the longer shots, we'll be using miniature skiffs, and Dave Carson is making up a whole bunch of tiny stop-motion figures to ride on one of them. They're about four or five inches tall and there'll be about a dozen of them on the skiff. We won't be doing any real elaborate animation, because the skiffs are simply flying by and the guys are essentially just standing there. But we'll be getting pretty close in some of the shots, so we want them to be able to sway a bit and react to the movements. Those shots will be matted into the background plates we shot down in Yuma.

The speeder-bike stuff that Dennis and Phil are doing for the forest battle is really quite amazing. The bikes themselves are supposed to be about the size of a Harley hog, only a little bit longer — maybe nine or ten feet long. The miniatures are eighteen inches, and the figures are about twelve to fifteen inches tall — about the same scale as the bike riders in *E.T.* Our guys seem to like working in that particular scale. The situation is similar to *E.T.*, too, in that you have somebody riding whose hands are attached to handlebars of some sort. And since you don't have to deal with the hands, you can deal with body movements, which are relatively controllable, by contorting the torso with rods — which are later roto'd out — and with a few strings. But unlike the go-motion technique developed for *Dragonslayer*, the moves are being done manually at speed, and you can get an amazing amount of action that looks really good — and actually works very well, even in a medium close shot. They're getting in really close on these things, and the cloth is blowing in the breeze. It's convincing — the illusion is there and the shots work, especially in the context of the forest battle where there are a lot of quick cuts. Everyone's been pretty well knocked out by it.

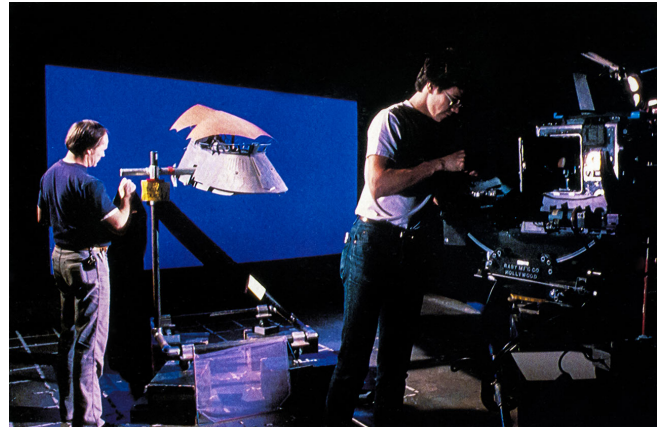
Right now, we have about twenty-five percent of all our elements shot, and maybe twenty finished composites. Several matte paintings have been completed so far, including the big one of the

shuttle coming into the landing bay of the Deathstar. The combination of painting and foreground miniatures looks terrific, and we've also matted in a couple of little guys who are welding or working on something in there. They're so tiny that even the most avid *Star Wars* fan probably won't notice them until his eighteenth viewing; but they're there, and it's one of those peripheral-type things that we do that makes the scene look more alive, even if you don't consciously see it. So, in addition to some paintings, we've also finished a few space shots, and a few of the Deathstar tunnel shots. Everything's starting to pick up speed.

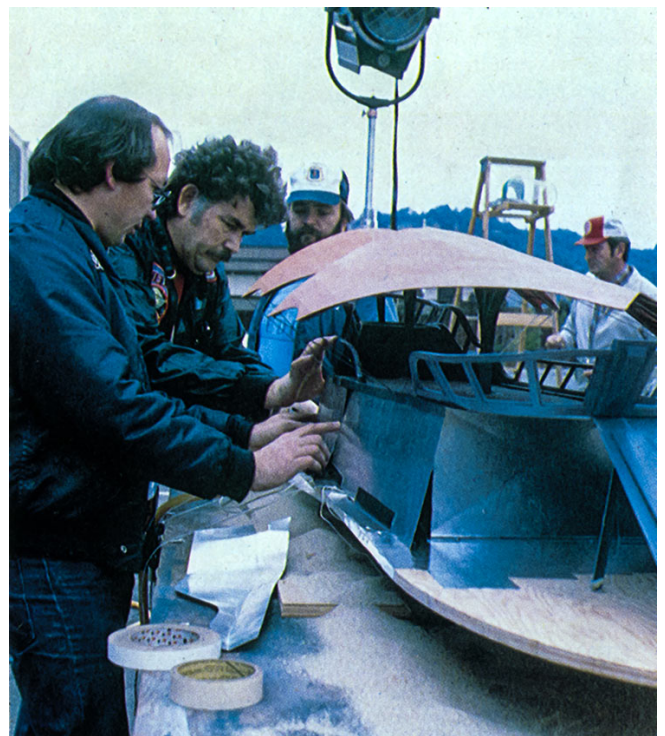
In optical, we've split the quad printer. The quad printer that I sort of designed for *Empire* has been split into two separate printers. I fought the idea at first, but when we actually looked at the situation, it was a better deal to have two printers than one super "trick" printer — even though the quad could work like one and a half. So we took the two extra projectors that were on the beam-splitting head, put those onto another bed, and put another camera there. And we're having another anamorphic lens built. So then, with the quad, we're going to rotate the beamsplitter 180 degrees, and instead of feeding four projectors into a single camera, we're going to feed two projectors each into two cameras. One camera will be able to shoot anamorphic material and the other camera will be set up to shoot spherical material. So at the end of *Revenge of the Jedi*, we'll be able to do something other than just an anamorphic picture. To date, we've been limited to doing anamorphic features — except for *E.T.*, which was done in 1.66:1 spherical and composited on my own 4-perf printer. Now we'll be able to do anything from TV commercials to super widescreen. So it'll be a pretty good trade-off.

17 October 1982 — RICHARD EDLUND

Production pressure is intense. We have much more to do, and not a whole lot of time left to do it in. We now have about eight camera crews shooting all the time, and we're finding that keeping the visual style straight, and all of those kinds of things, is more of a problem on this picture than we have had in the past. Joe Johnston has been going around and keeping track of each individual sequence — trying to make sure the style matches throughout the show, so the screen direction and key angle and all



Shots of the barge in motion were photographed using a five-foot model against a blue screen. Cameraman Don Dow wraps velvet around the model's mounting pipes, while assistant Patrick McArdle prepares the Vistarama motion control camera for shooting.



To contain and direct the first of two explosions, modelmakers Charles Bailey and Ira Keeler attach sheet

those kinds of things match. George, of course, is the driving force. He knows every frame in the picture, and he's over here at least twice a day for dailies. We're now using Monaco film Labs in San Francisco to develop our color film, so we have two dailies — one in the morning at eight-thirty and another in the evening at about six o'clock.

metal plates to the back side of a partial fiberglass barge model built especially for that purpose. The high-speed explosion shot was filmed outdoors, atop the LM stage, using a set comprised of sand transported from Arizona and a painted backdrop by Chris Evans. The first explosion — featuring the fiberglass model — was designed primarily to blow out the windows on the barge. The second, which obliterates the vessel, employed yet another barge fashioned from a brittle aggregate material.

My crews are still involved in flying ships through the interior of the Deathstar. Bill Neil has been shooting tunnels and all the various pans and things, and then Mike McAlister and his night crew have been coming in and shooting the ships. It's a real roller coaster ride — five or six rebel ships being chased by a half dozen TIE-ships, and they're going through these access tubes or ventilator shafts or whatever with just inches to spare on either side. And, of course, none of the rebels really know where they're going. They're just taking it as it comes, and there could be a solid wall ahead of them at every turn. As I expected it would be, we're finding that it's very difficult to deal with objects that are flying within geometric boundaries — just because you don't have that freedom of being out in space. Plus, when you have six or more ships and the scale of one ship is different from the next, and you have complex camera moves and pans, there are a lot of adjustments that have to be made and programmed into the system. Fortunately, the program-smoothing aid that Kris Brown developed is really coming through for us. Even though the basic move is still done by human hands, the computer can take that program — once you've shot a black-and-white RAR test with it — and plot it out axis by axis so you can see what the actual move looks like graphically on a video screen. Then, if you see a bump in it, you can take that bump out without disrupting the rest of the move that you may very well want to leave alone. When you get seven to ten axes going and you have to go back and correct one of those, this system allows you to separate it from the rest — so that's quite exciting. It's adding another arrow to your quiver, so to speak, and it really speeds up the process.

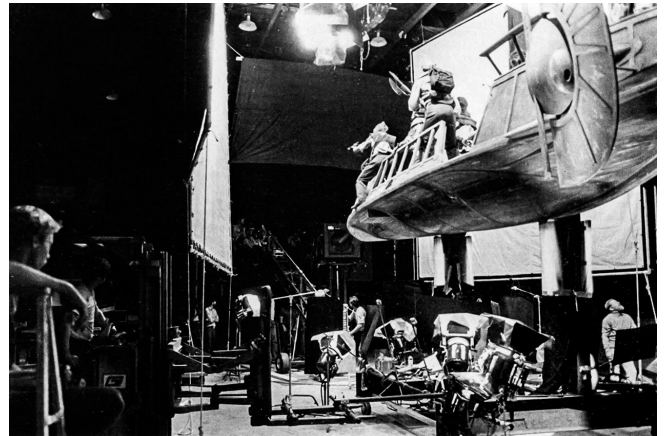
Right now, we're getting ready to shoot a big scene of the *Falcon* racing to get out of the Deathstar. They've fired their torpedo and the Deathstar is starting to blow up, and we have this scene where the *Falcon* is racing down one of the tunnels with a giant ball of fire right on its heels. Thaine Morris has developed some special pyrotechnics for the scene, and we've been doing some testing with a tunnel that's about four feet wide by three feet high — and about sixty feet long. There's only two shots — about four seconds total — so it struck me that what we needed to do was build a simple but relatively inexpensive track capable of running at a high rate of speed and yet still be dependable and sturdy enough to move smoothly without risking the camera getting caught up in the fire and burning down. So what the guys have engineered up is a real free-wheeling system using skateboard wheels. We'll have our high-speed VistaVision camera mounted on this track and propelled along by air rams which will give it a push — then it just sails on its own. There are about eighty pyrotechnic mortars along the length of the tunnel, which are triggered in sequence as the camera goes by. It's quite a complex series of events, and the amount of the charge and the spacing and detonating procedure is much more critical than anything we've done before. The trick is firing the mortars so you don't see the source of the explosions. What we're after is kind of a boxing glove of flame coming from deep inside the bowels of the Deathstar; so we want the source to look as

though it's coming from infinity, and not being replenished as we go along — which is what's actually happening.

Anyway, that's one of those things where you have to come up with a basic idea of what you want, and then just keep plugging away and experimenting until you get it. We've already run some tests through the tunnel — which doesn't have any detailing in it yet — and we'll be doing some more before we're finished. Right now, we're not even sure how fast we'll be shooting, but it probably won't be too fast. The final camera speed will have to be determined in relation to the speed of the walls going by. Once we've finished all our testing, Steve Gawley and his people will spend a few weeks putting detail work into the tunnels, and then we'll shoot it. If we're lucky, we'll get the shots in a few takes, since the pyro mixture actually ruins the set pretty quickly.

Some of our other pyrotechnics have been coming from the large library of explosions we photographed back during *Empire*. But Thaine has also developed some new ideas for sustaining flames and explosions on ships that are flying through the frame. Ken Ralston is doing quite a lot of that in his space battle. In the past, most of our ship explosions have been done by matting a high-speed explosion shot over the ship. In *Revenge*, though, Ken's doing some scenes where the ships are burning as they trail away in the distance and then explode. In some cases, those are matched-move situations where the ship is photographed normally on the first pass. Then, on the second pass, it would be set on fire — but not lit — so all you would get would be the flame exposure which would superimpose over the lit pass. In other cases, actual explosions are being projected onto the ships and photographed as the camera moves by with motion control.

Ken's sequence will be a major accomplishment. In *Star Wars*, it looked as though we had maybe half a dozen ships attacking the Deathstar, whereas in this picture, it's going to look much more like large-scale battle. Even though you're just focusing on certain people and certain ships, you'll get the sense that there's a lot of ships out there and a lot of men. So there are just thousands and thousands of elements to deal with — stage photography, animation, star fields, ships crossing in front of ships, shadows, reflections, explosions — it's very complicated. Some shots are likely to have thirty or forty different



At the tail end of the production schedule, cast and crew spent a week at ILM shooting Hue-action bluescreen elements which would later be optically combined with appropriate background material. Included were numerous shots employing the full-size skiff which was mounted on pylons and elevated off the stage floor so the underside could be lit to simulate reflections from the sand. Fluid motion was suggested by a combination of skiff and camera moves.



Longer views of the skiff were achieved by using a two-foot miniature, outfitted with an array of intricately detailed stop-motion characters sculpted by Dave Carson

elements. One of the interesting things with these battle sequences is that we now have such a backlog of already-photographed elements that it's getting to the point where some shots can be put together out of stock. We were able to do that on *Empire*, too, to a certain extent.

and Dave Sosalla. Ken Ralston — and later, Tom St. Amand — did the animation.

The forest battle is looking real good. Dennis has been working with the forest footage for the rocket bike sequence — going over it day after day, a frame at a time. Even with the Steadicam, there's a lot of movement in the plates — bounces and so forth — which actually give it an interesting, dynamic look. The problem is that the rocket bikes that fly into the shot have to have that same bounce — plus a bounce of their own — or else they'll look like they're just pasted onto the scene. So all that has to be matched and balanced, and in dailies we've been seeing a lot of bouncing rocket bikes that are on the screen for just a second or two. Some of the matting techniques that we developed through *Dragonslayer* and *Poltergeist* have really come in handy on this project, so hopefully we'll wind up with matte-line free, quality match material that'll look like the stuff was really *there*. It absolutely can't look fake, even though it *has* to be fake.

The picture's changed a great deal in the past few months, and we expect it'll continue to change as George continues cutting. Sequences are being changed around, and a few shots will get dropped here while a few more will get added there. It was like that on *Empire*. We came up with storyboards for the picture, which then got fiddled around with as we went along — whittled down in some cases, added to in others. The same thing is happening here, only in a more complex way. We try to economize whenever possible, but the show *will* be on the screen come the release date. Everything is a must-have, and every shot will be there. We're all well aware of that.

10 November 1982 — RICHARD EDLUMD

The further along we get on this, the more we're coming to realize the limitations of this facility — not in terms of equipment or people, but just in terms of space. With eight camera crews going, just juggling this postage stamp sized real estate that we have is a real challenge. We do have our large stage next door — which is not very large by Hollywood standards, since it's only about a hundred feet square, but it's very large by *our* standards. We have a lot going on over there; but the way ILM is set up, the motion control work is almost exclusively here in ILM proper, just because the electronic tracking cameras are the main tools of the show. And we're finding the ILM stage area is just *barely* big enough. We've kind of labyrinthized the stage, and we're working on a push-pull system where the blue screen is shared by the day and night crews, with the day crew shooting one way going down the track and the night crew shooting the other way down the track. So we have setups on either end, with four crews sharing two cameras. We've extended the length of the original Dykstraflex camera track by almost twenty feet — from forty-two feet to about sixty. Then we've got about eighty feet on the new VistaCruiser camera.

Our quota now is about fifty elements a week. Dennis is out sick at the moment, but his crews are still plugging away. Dennis and Phil Tippett have been doing a lot of work on the rocket bike sequence; and basically, they've come up with two different ways of dealing with the miniatures. One, of course, is to shoot with our more or less standard motion control techniques. But for side views where we want to see things like costumes blowing in the breeze, they've developed a way to

shoot at sound speed with the field recorder system using wind and moving clothes and working out programs to match the jiggle on the background plates. Otherwise, it doesn't look like it's shot from the same camera. Then that jiggle program has to be modified so that the object you're putting in has its own movement, but still has the movement from the background plate. To do that, Jerry Jeffress has come up with a way to automatically add those two programs together so you wind up with a good jiggle *and* a movement on the bike. The jiggle program is put into the field recorder camera, which sits on a dolly that can be pushed back and forth to create changes in image size. Dennis does the lighting on the shot, with Bob Elswit and his assistant, Kim Marks, doing most of the photography. Then Phil is in there with rods and strings on the puppets so the riders will appear to have the right movement. What you end up with is kind of a hybrid version of stop-motion animation where you can get real-time — or nearly real-time — movements on your puppets. In three seconds, you can shoot thirty hours worth of animation. It's also much faster than go-motion, and you're not locked into shooting seventy-five specific frames. There's a random factor involved, so they can shoot four or five takes and then pick the best one. It's working out quite well. In fact, the composites are starting to come through, and some of the shots are just great! You're looking at little puppets almost filling the screen, and there's virtually no way of telling.

We *are* doing some go-motion, though. Phil and Tom St. Amand are using it on the two-legged chickenwalkers. The walkers are hooked up to rods and the basic moves are programmed. Then Tom or Phil goes in between frames and tweaks it a bit for some of the smaller detail things. The technique is very effective. Standard stop-motion just doesn't seem to work for modern audiences. It just doesn't look right anymore. You can still go and see *King Kong* or *The 7th Voyage of Sinbad* and enjoy them because they have a "period" style and they work on that level. But they don't work on the same level as *Star Wars*. And so go-motion is kind of an adjunct to that, and a fairly natural extension of motion control technology.

Ken Ralston is still shooting his space battle footage. He's an old hand at that stuff, and I have a feeling he's probably shot more spaceships than any man alive. The matte department is really shining. Mike Pangrazio and Chris Evans and Frank Ordaz are doing some wonderful paintings, and Neil Krepela's been doing all the photography and finessing the shots. He's very attentive to detail, and real inventive. Meanwhile, the optical department is starting to get crushed, as is the animation department under Jim Keefer.

Myself, I just came back from a short vacation — a seven-night hunting trip up in northern Oregon. In my absence, Bill Neil and his crew continued with the tunnel shots inside the Deathstar, racing down within the superstructures. In fact, we finished the last of those today, so all the backgrounds have now been shot. Meanwhile, Mike McAlister has been shooting the ships for that sequence at night, and he had a really good style going when I left. So I didn't feel I had anything to worry about. Everything was in good hands, and Joe Johnston was keeping an eye on things from an art director's standpoint.

Today we did our first fire tunnel shot. We'd already done the testing before I left, starting with a high-speed 16mm camera and a couple of rails on the floor, and then gradually working up to a really fast track with skateboard wheels. We shot a couple of tests with my 35mm Eyemo, and then did one with the VistaVision camera — with no detail in the tunnel. There must have been about six or seven film tests in all — primarily to work out the right camera speed and the proper mixture for

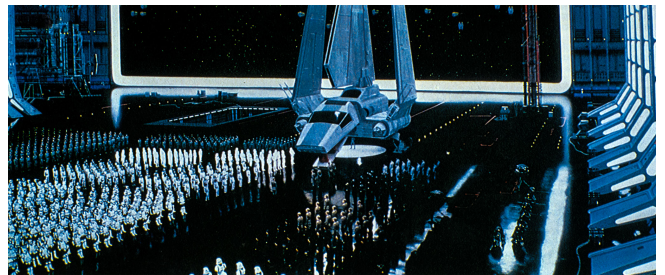
the pyrotechnics. Once we had that down, Steve Gawley — king of the tunnels — came in with his crew and detailed up the miniature, which was no small task since the thing was sixty feet long. The camera itself was enclosed in a fireproof sack and propelled along by an air ram so that it went from one end of the track to the other in about two and a half seconds. The pyrotechnics were sequenced — several *pounds* of pyrotechnics, in fact — so there's a helluva lot of flame in there. It starts back and then gains on the camera — and it was really impressive. Assuming the shot is okay — and we'll know tomorrow in dailies — we'll then go on to our second shot where the flame actually catches up and engulfs the camera. Fortunately, the tunnel didn't take too much of a beating, so I think we can go ahead and shoot it pretty much as is for the closer shot. I don't think we could get six shots out of it without completely destroying it — but we can probably get three or four, if we have to. By the time we get to the third one, we might have to go in for a new paint job; but at least it's not catching fire and melting and all that stuff. We had five or six fire extinguishers ready to go if anything happened — but it didn't.



Modelmakers Jeff Mann and William George add detail work to the Emperor's new under-construction Deathstar.



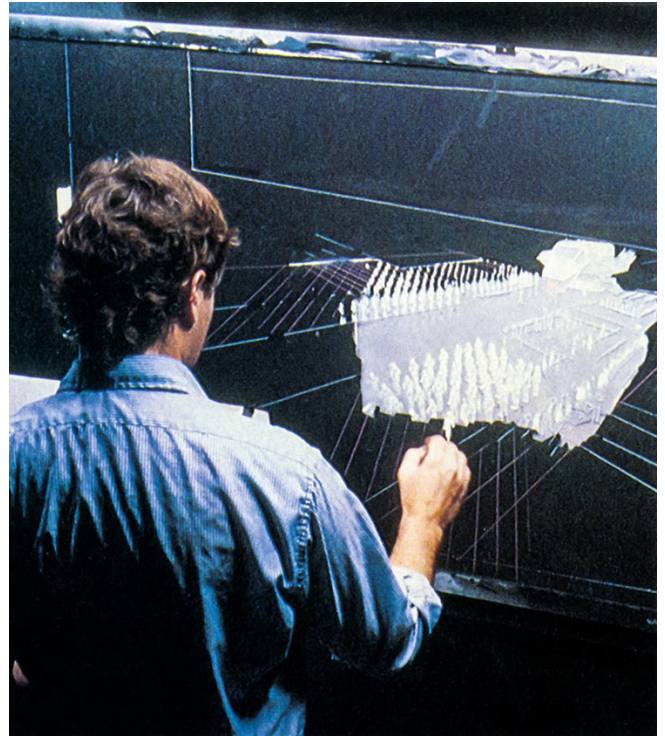
Camera assistant Ray Gilbert makes lighting adjustments on the completed miniature, which is mounted in front of one of the ILM custom fluorescent blue screens.



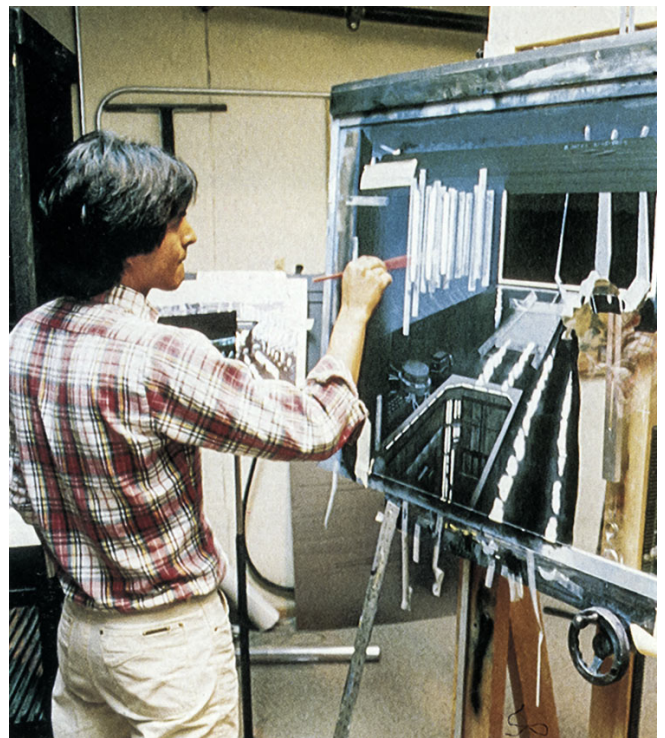
As TIE-ships and shuttles pass by in the distance, thousands of troops assemble in the Deathstar's main docking bay to honor the arrival of the Emperor.

We've started to get into the barge sequence. We're in the process now of building a couple five-foot miniatures of Jabba the Hutt's barge — one of which we'll be hauling out into the desert to blow up. That way, we'll be able to shoot it in sunlight against a natural background and not have to deal with shooting blue-screen. We will be doing some bluescreen work, though — some earlier long shots of the barge drifting over the sand. We're also trying another kind of interesting technique on one of the shots that was done down in Yuma involving the full-size barge set and some of the live actors moving around on the deck. The idea is to isolate the barge from the background by doing an absolutely perfect roto matte and then matting that over a new background that's being painted. By doing that, Bruce Nicholson can shoot a combination zoom and pan on the optical printer which will make it look as though the barge is actually sliding into place. For all the other live-action shots, of course, it's just sitting there; so this would make everything look more alive, because you'll see the actual barge moving, with some real guys walking around on deck. I think with that — and some long miniature shots, which won't have any moving characters — we'll be able to establish for the audience that the thing is actually levitating. We've done some initial tests that look promising, so hopefully the idea will work.

A recent development is that George has decided that there are too many effects shots — which is tending to slow the picture down. So he's in the process of restructuring a few of the sequences, and there's a possibility that we're going to get a cutback in the number of shots we have to do. After all, a lot of the ILM material — especially with the spaceships — is really environmental establishment. Granted, you're seeing events take place that are necessary to the story — but a lot of them are not and, really, your attention should be focused on the actors. That's what George has in mind. I don't think he'll be cutting any sequences outright — just paring them down a bit and getting rid of some of the extraneous



Mike Pangrazio draws in perspective lines before commencing to paint. The lightened area in the center of the panel represents the live-action plate, photographed at EMI Elstree. The remainder of the frame is painted — with miniature spacecraft projected into the open area from the rear.



Frank Ordaz at work on an alternate view inside the docking bay.

shots that are slowing things down. Frankly, we're not unhappy to see that he's making fewer shots for us to do. We all want the movie to be as good as it can, but we don't want to do a lot of extra work either. Cutting back a bit means we'll have more time to do a better job on the ones we have left.

22 November 1982 — KEN RALSTON

My first involvement on *Jedi* was over a year ago. I started out in the "monster shop" with Phil Tippett and Dave Carson and spent a couple months designing prototype creatures for the film. In fact, I think about four or five of my designs actually made it into the show — which is kind of neat, to know they got that far. Then *Star Trek II* came along and I was pulled out of the monster shop to work on that — which was really more along the lines of what I wanted to do. All the while, of course, we knew *Revenge of the Jedi* was coming up and that *everybody* would be involved in it; and one of the First things they tried to do was figure out a way to split up the work. It was kind of arbitrary, in a way, but for the most part they tried to give the work to whichever of us they thought might be able to give those sequences a little bit more, maybe, than the next guy. As a result, I wound up getting the space battle stuff — mainly because I've done so much of it.

The space battle is one of three or four different action sequences, all going on at the same time and all leading up to the big finish in the film. Lando is up in the *Falcon*, flying around with all the rebels who are trying to get to the Deathstar and put it out of commission. But just *getting* there is almost impossible because they're confronted by a huge army of bad guys, and there's just hundreds and hundreds of enemy fighters and destroyers.

Basically what George wants is mayhem — cutting back and forth between the space battle and the ground battle and what's going on in the Deathstar. And he's building the pace throughout the whole thing by cutting from action to action. It never stops. George has just finished a major restructuring of the effects sequences — cutting some things, adding others — so we're in kind of an upheaval at the moment. He wants a real feeling of grandeur and awe, and he's trying to get a much bigger sense to the size of these things. So the complexity of the shots is far greater than anything I've ever done. In some of them, there *are* literally hundreds of ships. The ships that are furthest away — the ones that are basically dots — are usually just photo cutouts mounted on glass; and we might shoot a couple of different panes of glass just to give the ships a certain feeling of depth and independent motion so they don't look totally locked off — so they're moving amongst themselves. But for the most part, the ships you can see are all motion control miniatures — all shot separately and composited together. On the original *Star Wars*, there were a lot of shots where three



Modelmaker Bill George adds painted surface detail to the nearly-completed Imperial shuttle, one of several new spacecraft designed and built for the third installment of the *Star Wars* saga. Since the shuttle was to figure prominently in the live-action photography, the forward command module and embarkation ramp were constructed on stage at EMI Elstree. Then, for a number of expansive matte shots, the remainder of the craft was painted in.

or four ships were all photographed together at once, but we're not able to get away with that anymore. Audiences are more sophisticated. They won't buy that anymore. We won't buy that anymore. It just looks too locked off. If you're doing them one at a time, you have much more flexibility. We have shots where the *Falcon's* coming at you, and behind it are five X-wings, three A-wings and a couple Y-wings — and they're all doing their own little maneuvers. You might not be able to follow it, as such — but it reads subconsciously, I'm sure. And it really helps the credibility of the scene.

One shot has probably fifty TIE-ships, all shot separately. If you were really out there in space and looking down from above, you'd see them flying in two levels — like two floors of a building. Then there's three or four X-wings that we're following into that bunch. They drop down through one level of TIE-ships into the next and then start shooting. That'll probably be our biggest shot in the film.

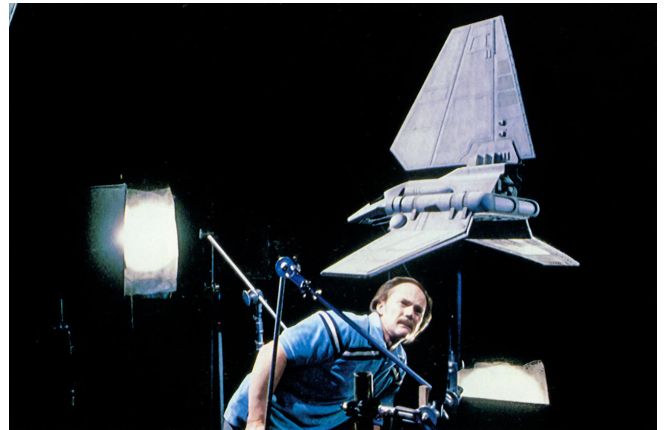
We have some new pieces of equipment — and some refinements on a few of our old ones — but technically, we don't have any real innovations. Basically, we're pushing *ourselves* this time more than the machines. We know how to use those machines and those cameras, and now it's up to us to give our shots a little bit more than the other shows had. We're not limited by the system as much as we were on the first show — or even on *Empire*. And we're all enjoying the challenge. Nobody wants to just go out there and plug himself in and say; "Okay, here we go. Another Y-wing flies from left to right." Some of that's fine because it's just background. It still has to look good, but it's basically just visual filler for the main action that's happening in front of you. For *that*, everyone's putting out a thousand percent. One thing we're trying to do is keep the camera moving — even if it's very subtle — loosening things up, making the shots more fluid and giving them more of a feeling of immediacy. So we may be following this one particular guy, and we'll pan over with him and reveal a whole fleet of ships and all this other action taking place. That may sound simple, but it's really complicated, because you have to constantly use the same master program over and over and make everything lock into it — which is a major problem in itself, just having the ships timed right so they're all doing what they're supposed to be doing.

We have one shot where the *Falcon's* chasing some interceptors around one of the hospital ships and the camera is following right behind them. It's really neat, because you go around the ship and underneath it and all the while the *Falcon's* blowing up all these enemy fighters. And it has a terrific feeling of flying. In fact, there's one particular moment — when you come up over the top of the hospital ship following this interceptor — that gives you a feeling almost as if you're falling. We're trying to get a lot of that type of thing into the show. And the pace is going to be unrelenting — worse than *Raiders*. They'll have to have seatbelts in the theaters — and barf-bags.

We're finding that choreography is *very* important. Most of the shots are quite short, and some of them are so busy — ships flying around and explosions all over the place — that we'll be in dailies and the shot'll come and go and we'll still be sitting there wondering what the hell it was. All you can see is movement. We had some of the same kinds of problems on *Empire* with the asteroid sequence. About the only way around it is to choreograph the main action in such a way that you don't lose it amongst all the craziness going on that could easily pull your eye away from it and make you miss whatever it is George really wants you to see. A lot of the changes George is making

now are being made with that in mind — and in some shots we're pulling stuff out because we were confusing the story point with overkill.

There's also a tremendous amount of organizational work involved. We have one shot that's finished now that's probably the biggest shot we've ever done at ILM. Lando is flying around in the *Falcon* and he looks outside the cockpit window and there's a whole fleet of TIE-ships coming at him. Not only is there a fleet of ships out there, but also lasers shooting and flak blowing up. And it's all moving, so the star fields are also moving. Of course, in the show, it'll be about a second and a half long and you'll be lucky if you even remember it. But it's a very complex shot with about forty or fifty elements in it, and keeping everything organized was no easy task — especially when you're working on fifteen or twenty different shots at once. I'd love to be able to start a shot and go on through and complete it. But for scheduling reasons, we can't do that. So we do a piece of one shot and then go and do a piece of another. Just on what I'm doing we have four and sometimes five crews — working around the clock because there's so much to do and not enough time to do it in. Everybody's got to be communicating about everything, and one of my major challenges is just keeping everything organized — giving my crews the most up-to-date information possible and trying to keep on top of all the changes that are being made.

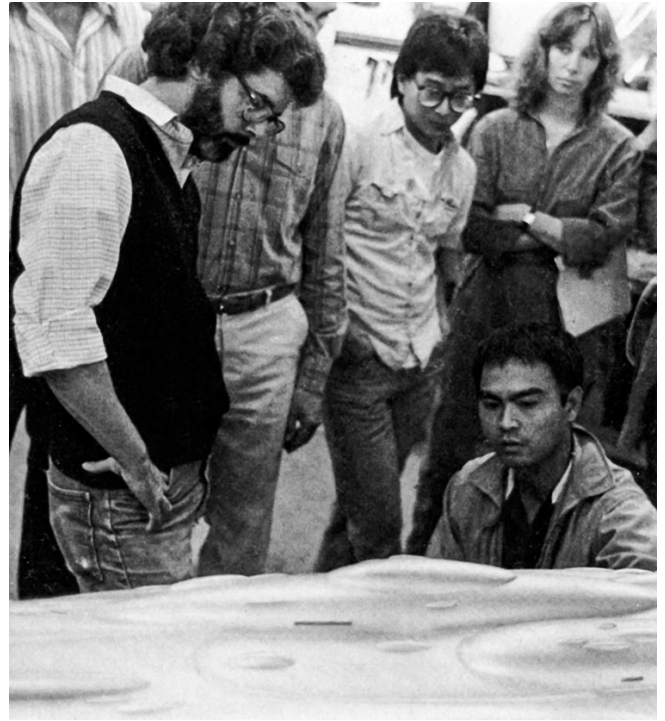


Cameraman Don Dow makes a lighting adjustment on the Imperial shuttle.

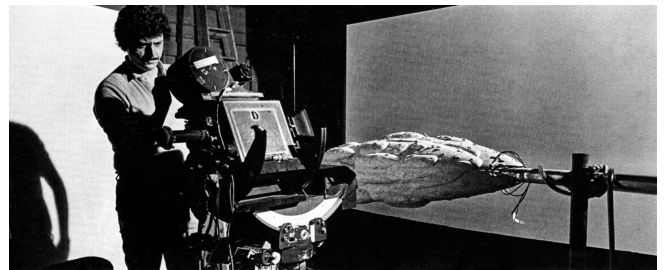
After we get about eighty percent of a shot done, we do a black-and-white composite — very rough — so George can cut it into the picture and start evaluating it. It also gives us a chance to do the same. On a really complicated shot, we'll wind up with maybe ten percent of the elements that don't really work. The precomp allows us to look it over and see what is working, and then go back and much more easily redesign whatever is not. It's just better when you can see something in concrete form, rather than having to rely on guesswork all the time.

In the latest purge, I had thirty-six shots cut — which sounds like a lot, but then I had some other miscellaneous space stuff added. Unfortunately, some of the shots George cut were about ninety percent completed, which hurts. He also cut some others that I was just in love with — and I'm now fighting to get a couple of them back in, just because they're really neat shots and I'd like to see them in the show. One is an A-wing being chased by a TIE-ship. It sounds real basic. They're flying around one of the big domes on a star destroyer and the camera's making the same maneuver they are. The dome is huge in the shot and there're big explosions being projected all over the place, and you're pulling up into the air with them as they go underneath. It's one of those shots that even when you first see it storyboarded, you know it'll probably be a real beauty. And it was coming along real nicely. As you watched it, you'd get a real feeling of upward motion. Everybody liked it. But it got tossed. So now I'm pleading with George to put it back in. Of course, George works from a different point of view. He wants to keep the story from getting so convoluted and confusing that by the end of the film you don't know what you've seen. And I have a feeling he cut that particular shot because the one right after it is of Admiral Ackbar — who's kind of a squid-head creature that *Phil* designed — and he said a line that was totally pointless. So George was trying to cut back and tossed them both. I'm hoping, though, that he'll find another place for it. Plus, there were a few more I was really sorry to see go — especially when you consider there are always others that are basically ugly shots, but you still have to put your best effort into them.

All together, we ended up dropping hundreds of completed elements because of shots that were cut. That's just the way it happens sometimes. At the moment, the space battle has probably about ninety shots. Then there are some other sequences — like the into-hyperspace sequence which has



In the ILM model shop, George Lucas and Nilo Rodis-Jamero examine the surface of the new rebel cruiser — designed by the two in conjunction with Joe Johnston.



Assistant cameraman Ray Gilberti sets up a motion control bluescreen shot on the cruiser.

about eight shots, an approach to Darth's ship which is probably twelve, plus some other transitional things. In all, there must be a hundred and fifty, just for me. And some of them are *really* hard. Richard had a lot of shots cut from his sequences, too; but Dennis is in kind of a rotten position on the bike chase. Everything's happening so fast in that sequence that George can't really cut it back until Dennis is finished with it — which is terrible. The matte department wasn't cut at all. In fact, they picked up thirty or thirty-five shots George thought were necessary to help tell the story and clarify where everyone was and what was going on. The animation department picked up some added animation and a lot of new roto mattes. And, of course, optical wasn't helped at all. They just have more work to do because of the new shots.

Right now, we're all working toward a deadline which I hope we can make. At the moment, we have only about twelve or thirteen composites that are actually finished, although the stage work is done on a lot of others and some of those are very, very close. But by Christmas, we have to get all of the key elements of all the shots done in black-and-white and cut into the film —just the main action, not the background stuff — so they can cut it and lock it in and get it ready for putting the music and sound effects to it. Frankly, I don't think I can get all my stuff done by then — maybe ninety percent. Richard, I think, will be in pretty good shape. I don't know about Dennis. If we get desperate, I guess we can always cut in our videomatics.

9 December 1982 — DENNIS MUREN

I was still involved with *E.T.* when *Revenge of the Jedi* started up. Right from the beginning, it was decided that I would do all the land-based effects, and that Richard and Ken would split up the space stuff. For me, that meant three different sequences. The first is in Jabba's palace, where Luke drops down into a large pit and there's a big doorway that opens up and out comes the Rancor creature — an eighteen- or nineteen-foot-tall man-shaped lizard-type creature that Luke has to fight. The second is the rocket bike chase where Luke and Leia pursue two troopers through the forest on flying motorcycle-type vehicles that travel about a hundred miles an hour. The third is a big forest battle with the furry little ewok critters being attacked by some two-legged walkers — which Joe Johnston and Jon Berg had designed for a couple of shots in *Empire*, and which got a good response. That sequence involves some bikes, as well, and will be intercut with the big space battle at the end of the film. And, of course, there's always some extra little things on the side.

While *E.T.* was still going on, we started shooting what we call "videomatics" — which are video versions of the effects sequences, done very quickly so that George, and ourselves, could cut them together and come up with a feel for the sequences. We'd done rough cartoon versions of effects sequences before, but the idea of doing video versions was a new one. The first thing we did was the bike chase. George started out by asking Joe Johnston and me to make up the entire sequence. We wrote down various things that might happen on such a chase, and we looked at some movie car chases — most of which weren't very applicable. But soon we'd devised a two- or three-minute sequence that had lots of danger, twists and thrills in it. George looked at it and jazzed it up some more; and from that, Joe did a new set of storyboards. Then came the idea of shooting a motion version of the boards. At first, I tried to get the guys over at Sprocket Systems (Lucasfilm's computer division) to come up with some computer-generated images — to make sort of a quick video game type thing with just outlines and stuff to see what the movements would be. But they were pretty

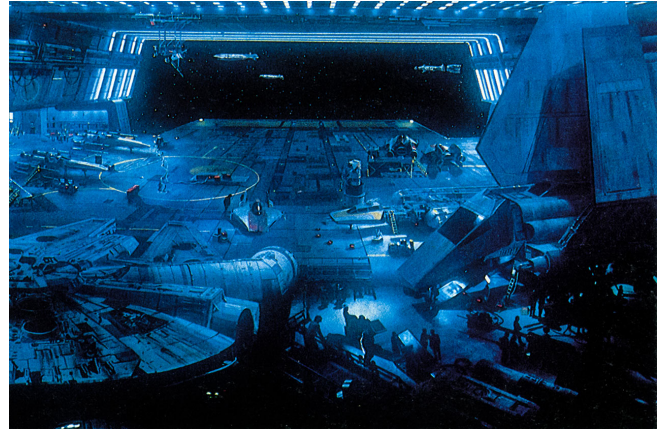
busy finishing up their work on *Trek* at the time and that never quite came together. So instead, Joe Johnston and I took a little mockup of the bike, along with some Luke and Leia action figures — about six inches tall — and without any attempt to conceal the rods and supports, we did a quick video version of the storyboards in a span of about three days. The set we used was just two four-by-eight sheets of plywood with a rug across it and some cardboard tubes for trees. Nothing very fancy. All we were trying to do was get a feel for the sequence, so the idea was to keep it simple and manageable so it wouldn't take *any* time at all to set up. Otherwise, we'd be putting more effort into it than we should. As we got into it, we improved a few shots and even came up with alternate angles. George took that stuff and fiddled around with it and edited it, and it worked out so well that he decided to go ahead and invest in an UltiMatte system with a good video camera and a stage set up for video blue. It took about a month to get that going. Then we went in and did a video version of the Rancor pit sequence, using a gorilla suit we borrowed from Chris Walas. With the UltiMatte system, we could go ahead and composite in backgrounds, and those came out really good. Good for our purposes, anyway. You couldn't use them for anything commercial — not even the worst Saturday morning kid show — but to give us a sense of tempo and scale, they were just perfect. Most of the effects sequences ended up being done that way. The original idea had been to have each supervisor shoot the video stuff for his own sequences. I did most of mine, and Ken and Richard did some; but it turned out that the space videomatics took longer to shoot than anyone figured and so they ended up having the camera operators do a lot of them.



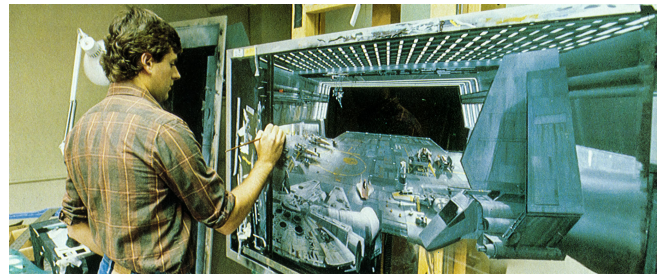
Effects supervisor Ken Ralston makes minor adjustments on a new large-scale X-wing. With its five-foot wing span — as compared to the standard one-foot models — the new fighter could be used in tight closeup. In fact, when needed, the puppet pilot was large enough to be animated through the shot.

Long about February, I went over to England and sort of supervised — “watched” is really more like it — the live-action plate and bluescreen shooting for the Rancor pit sequence. *E.T.* was still in the works at that time, but I needed to be over there just to make sure the plate photography was going okay and that everything would eventually come together. Came back, finished up the spaceship shooting on *E.T.*, and then jumped off and went on up to Crescent City for the location shooting on the walker battle sequence in the forest. We had two crews up there for six weeks and we just shot tons of VistaVision plates, right alongside the first unit — lots of times not even worrying about locking them down. ILM has reached a point, I think, where we can do practically *anything*. Not really “anything” — but we can do some incredible salvage jobs, especially by using the capability of our animation department to reposition and move things throughout the frame, as we did on some of the tauntaun shots in *Empire*. I don’t think we need to really lock the camera down very much in a lot of situations; and as a result, the shots you’ll get will look much more natural and real. So we went into it, without our field recorder system or anything, and just winged a bunch of shots — moving the camera, panning and tilting, doing it absolutely freely. Any time the first unit was shooting, we put up a VistaVision camera and shot along with them. And we ended up with probably hundreds of thousands of feet of film — some of it with pans and tilts and all the kinds of things you just can’t do if you’re planning to go in and add effects. But we did it without worrying about that, and brought all this footage back for George to work with in editing the sequence — and now we’re figuring out ways to actually deal with it.

We knew from the start that the final bike chase would be a combination of live-action closeups against bluescreen and then miniatures for the longer shots. Right after we finished up the walker battle in Crescent City, everybody came down to ILM and we shot for about seven or eight days on our stage with the actors and full-size bikes against our new huge blue screen. At that point, we hadn’t shot the background plates, so we had to guess on what the lighting was going to be like. That wasn’t exactly ideal from our point of view, but it was dictated by the economics of the business. We had this extra week at the end of the shooting schedule, and to bring the actors back at a later time would have cost a fortune. So I had Mike McAlister go out on a motorcycle and ride around in the woods — with a camera attached to the front and side — just to see what the lighting really did and kind of use that for a guide. And it was very strange. Soft light from underneath him would come up and then fade down, and there were great things with changing colors as the bike



After photography was completed in the Deathstar docking bay set, the stage was converted into a docking bay for the rebel cruiser.



Mike Pangrazio adds finishing touches to the elaborate matte painting which fleshed out the shot and gave it a grand scale. The clear glass area in the lower right represents the live-action portion of the frame, which would be composited into the painting via rear projection.

went in and out of pools of light. But there wasn't any sense of speed — it just didn't look very fast. So when we did the live-action stage stuff, we dramatized it a bit by giving it more flash-type lighting, with things whipping alongside of them. We must have had at least ten separate lighting units — each with a cluster of six or eight lights flashing at certain intervals. It took a crew of twenty or twenty-five guys just to manage it all. Most of the footage was shot at 20 or 22 frames per second to help make the actors look like their reflexes were very fast while on these bikes. The bike chase is about two-and-a-half or three minutes long, with something like a hundred shots — most of them no longer than about sixty frames. But rather than try to shoot the storyboard, we shot the whole sequence, in continuity, from each angle — front views, side views, closeups — all the way through. That way, George would have a lot of choices when he came to editing it.

George is quite remarkable in that regard. He's very much aware that you're making a movie — you're not just doing a shot. You can give him eight shots all together in a series, and say shot number five looks funny, or it doesn't work out for some reason. Well, he doesn't just cut number five short; he cuts all the shots around it to make number five *work*, because everything relates to everything else. Cut number five short and it may look like you cut it short — the pacing's not there. George likes to have a lot of material to cut with, and he doesn't mind shifting things all over the place. The bike chase is cut together in rough form, and when we're through with it and we have comps on everything — which will be pretty quick now — you can bet he'll go back in and recut it. And we've shot everything almost fifty percent longer to give him the room to be able to do that. By the time he's through, the whole film will have a very definite rhythm that's all George's. And that's nothing you can get from reading a book on how to cut a movie. It's intuitive.



At the end of principal photography, actors Mark Hamill and Carrie Fisher spent several days straddling a speeder-bike in front of ILM's king-size blue screen. An elaborate light sequencing system was devised by Dennis Muren to create an interactive lighting effect on the riders akin to what would have been recorded if they were racing through a real forest.

By the time the live-action bluescreen bike stuff was shot and George came up with his next cut for the sequence — which was made up of bluescreen actors and videomatics — we could turn our attention to the background plates for that sequence. We'd already spent quite a lot of time trying to figure how to do the forest. Our first reaction was predictable — we'll build a model. That's always ILM's approach. And it was a way to do it. Back in December (1981), I had asked Dave Carson to make a miniature version of what we'd eventually need, and from that we did some figuring. In order to get a fairly good sense of speed, the bike had to be going a little over a hundred miles an hour. Based on that and a seventy-frame cut, then, how big would the model have to be? And how big would the backing have to be that went behind it? It wasn't like shooting the Deathstar trench in the first *Star Wars* where all we needed was a black background to put a few stars in and where most of what was off in the distance was hidden by the walls on both sides, anyway. With a forest set, you'd have to be able to see off for quite a ways on either side. We determined that in order to get any sense of scale, the trees would have to be quite large; and even with the smallest little periscope lens we could get, we'd still have to hinge the trees to get them out of the way as the camera went by. It was still possible, but the model would have to be huge. Then we'd have to set it up on our eighty-foot track stage and completely take over for about a three-month period until everything was done. It just didn't seem to be the best way to go.

Earlier in December, I went scouting for locations up north. Dave Carson and I went up — Mike Pangrazio and Paul Huston went, too — and we stood around shaking our heads and telling each other this was going to be a really tough thing to try and build. Branches were sticking out all over the place and there was this canopy over the forest. Even if we could duplicate it, just moving the camera through would be a real problem. While we were up there, I took a Bolex and shot some 16mm footage — about eight frames a second — as I walked through the trees. I figured it might be useful for reference.

Driving back, I started looking out the side of the car, and suddenly realized that we could probably do all the side shots *from* a car. As long as we were close to the trees, there wouldn't be any way of



Although most of the film's new creatures were concocted at ILM, the diminutive, but feisty, ewoks were a product of Stuart Freeborn's British-based makeup facility.



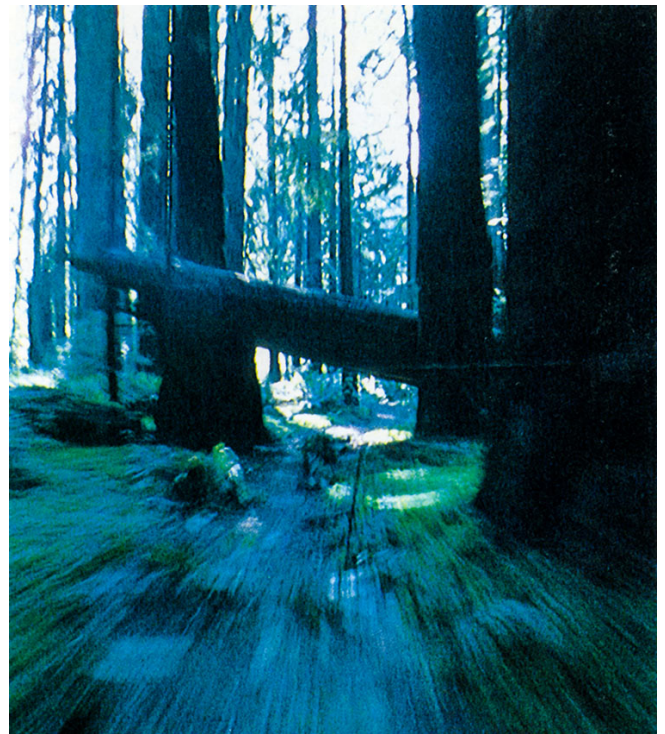
One of the primitive ewoks commandeers a high-tech speeder-bike and sparks a diversionary chase through the forest. While Richard Marquand gives direction, cameraman Mike McAlister captures the bluescreen action, using a VistaVision camera mounted on a rotation device.

knowing. Also, about half of the scenes are closeups of actors, and we figured if the road went through the forest we could still shoot straight on — forward or backwards — and you wouldn't be able to see the road because the actors' bodies would be in front of it. So about all that left were the fixed camera panning shots where you see a bike fly by the camera — which are easy to do — and then the front and rear POVs. We were talking about maybe twenty POV shots in the whole show. So is it even worth spending all this time on an elaborate forest model for only twenty shots? Plus, what would the credibility of the model be? For a while you'd probably get a magical flying kind of feeling — like we had with *E.T.* — but a lot of the film takes place in the forest, and we'd be intercutting with the actual thing, which could create a real credibility problem.

So I started thinking about what we could do to use the real forest. The bikes we could bluescreen in, because we'd have to do maneuvers with people on them anyway. So we just needed to be able to generate the plates. We thought about maybe hanging the camera from a cable — a 300-foot-long cable — and running it through the woods. But then we could just go in a straight line, and we wanted to have some banks. Helicopters were out, because we couldn't possibly get low enough. Motorcycles would show the path. A 400-foot dolly was a possibility. We thought about the Bell hovercraft, but that's unavailable except to the military. We even looked into a jet-pack — one of those things you strap on and it takes off. Nelson Tyler has one for \$6000 a day that goes thirty miles an hour. But to get the speed we wanted, we'd have to shoot at six frames per second and we were afraid it might shake all over the place. We also thought about Steadicam, but then started to dismiss it for the same reason — it shakes too much if it has to shoot at very slow speeds. But does it really? What if we get the best Steadicam operator in the world — the man who invented it — and what if we set up a video system for him with a telephoto lens, and put a wide-angle lens on the film camera, and have points that he can aim at so he can correct bumps all the time? We shoot at one frame a second — about seven feet of travel per frame — which equates out to around a hundred and twenty miles an hour. We set up a narrow pathway for him on the ground, and we have him walk as steady as he can. And this is what we ended up doing.

The first thing we did was talk to Garrett Brown, who got quite excited about doing it and agreed to come up for a test. He's a great guy; and over the phone, he and Mike Owens got it ready. We rigged the Steadicam with a lightweight Arriflex camera and then went out in the woods and set up a string at the right height for the camera — which acted as a height guide for Garrett. But the Steadicam has only an eighteen-inch height variation, which turned out to be the tradeoff we had to make for using that approach. We couldn't quite get the feeling of flying — that feeling of elevating up into the air and going down over things — which is one of the things I had really hoped we could do. Anyway, we ran this string out for a span of three or four hundred feet, which is about what we needed to get a sixty-frame shot. We also had marks on the ground that only Garrett could see, so he could keep track of left and right drifting. And he just walked *very* carefully along this predetermined path, correcting the camera shake when needed. It took maybe two minutes to shoot. Although we were shooting with a 20mm lens, we had a small Hitachi video camera below with a telephoto lens, which of course magnified every little error he made. So by looking at the video monitor — not through the camera — he was able to see the bumps better and correct them, practically for every frame. The test worked out fine, so we went up to Eureka and spent about three days shooting a bunch of plates. Gene Whiteman and Mike Owens had worked together to create a

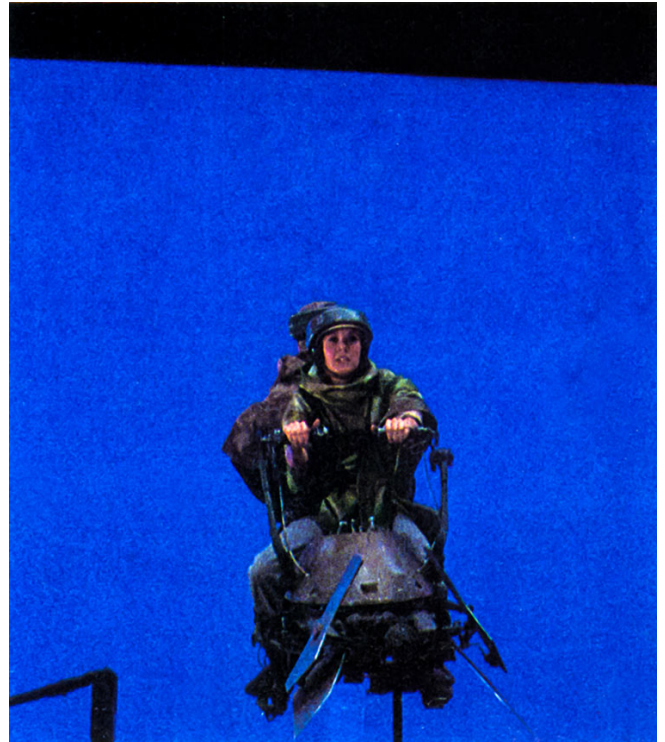
lightweight version of a VistaVision butterfly camera, in a roll cage so it would bank as it turned. I picked the paths, and our stage crew carefully dressed the ground to get rid of holes and branches. Garrett and Mike would walk along, with Mike talking to Garrett about upcoming obstacles. I was working the motorized roll cage. About three months later, we went back and shot for another day or two. So that's how we got the forward and backward plates. Still, it wasn't all as easy as it might sound. Later at ILM, Pete Amundson — the bike chase editor — and I spent nearly three weeks picking the right plates for the right moment. Some takes were smooth for sixty frames and then a bump would ruin them. We ran some of the best takes in reverse and some mirror imaged — and some both — to get the variety and quantity we needed. Initially, we had a little trouble getting rid of the string; and in some of the first shots we did, you can see it just slightly — usually when they go in and out of the light. Since then, we've been able to get rid of them, mostly in the printer. As it turned out, that Steadicam approach was really the only way to go. Our stage cameras have been totally jammed for months, twenty-four hours a day, and there would have been no way we could have gotten this much work done if we'd had that big forest model sitting in there taking up camera time and space.



A portion of a single frame of background imagery used in the speeder-bike chase.

Of the hundred or so shots in the bike chase, about half were the medium shots and closeups we did with the actors. That was fairly straightforward bluescreen work, except that Bruce Nicholson had to figure out how to pull mattes off all this stuff we'd done with lights flickering and flashing and all sorts of things going on. For the live-action shoot, the bikes and actors were on Tulip crane arms, with blue paddles to help conceal the mounts; but there's still a lot of roto work involved from Jim Keefer's department — getting rid of supports and rods and things.

For the side views, in addition to putting bikes and riders over the background plates, we're also putting in other foreground material racing by between the bikes and the camera. And every place we can do it, we're making roto mattes to put the bikes — whether they're real in the shot or motion control miniatures — *behind* trees that look like they ought to be closer to the camera than the bikes should be. So if it's necessary, we wipe the bike off for those few frames so it doesn't look like it's just stuck onto the scene. But, of course, we're going terribly fast, so the wipes need to have a blur in them. Sam Comstock has worked out a system with streaks and lines which gives kind of a soft-edged look to the things — which is pretty hard to do with hi-con stock — and that's worked out pretty well. We've kind of minimized that for some of the side shots, though, because we've found that just putting stuff in front of the bikes and background looks almost as good. We spent a lot of time studying real plates that Mike McAlister shot from a car, just to see what it actually looked like. What we found were all these incredible little highlights and glints and streaks and big black blobs. There's no real way, even, of knowing exactly what they are — but that's what's really out there. So we set up a little set that imitates that, just to give us what we needed to go in over these shots. There's no apparent logic to the patterns you're seeing; but when you run the shots, it looks very much like what you'd really see.



Live-action elements of Luke and Leia were photographed against a blue screen. From there, mattes could be generated, enabling the ILM optical department to combine the two pieces of film.



A cover matte, run with the bluescreen element, prevents any print-through onto the background forest plate. The grayish area immediately around the figure is derived directly from the bluescreen element, while the darker

area outside is a garbage matte rotoscoped in the animation department. The background is painted on a piece of paper, and the bikes and riders are placed in the scene by carefully tracing a predetermined path through the forest while shooting at one frame per second.

For our miniature bikes and riders, we're using kind of a new technique that's an offshoot from some of the things we learned doing go-motion on *E.T.* Mike Fulmer made two or three bikes that are just unbelievably beautiful. And then there were Luke and Leia figures and biker figures and armatures built by Tom St. Amand. The Figures were about fifteen inches tall — the same scale as the *E.T.* figures — and we were able to get incredibly close on them.

On *E.T.*, though, it took Mike McAlister an awful lot of time to rig up the go-motion motors just to turn a head. The main reason for that was because we always put in blue pylons to get rid of our model supports. Otherwise, the roto department would have to do a lot of articulate mattes on the edges. So we'd motorize everything and see where the rod was, and then position a pylon in there and shoot. That's been a lot of the thinking behind doing this kind of stuff with motors. But if you disregard that and just put a black rod in and say, "Sorry, roto, but you're going to have to articulate the edge of that every time," then all we'd really have to do is have a person standing there during the shot and just do it all by hand. Which is what we're doing. We have one rod coming out of the back of each puppet, and one rod out of the head. The Figures are armatured just like a stop-motion puppet — only considerably looser — and it's really amazing what you can do just by moving these two little rods. Fortunately, the hands are connected to the handlebars, or we wouldn't be able to do it; we wouldn't even have *tried* if the hands weren't connected. And the handlebars are rigid, which helps. They don't move like they do on a bicycle, so we didn't have to worry about that. All we have is the puppet, and with just the two simple rods, we're able to get an incredible amount of really lifelike movement, shooting at one to six frames per second.

A lot of the shots we have are fairly close side views of the models, with wind blowing through clothing and things like that. Bob Elswit came in to shoot that stuff, and we did a lot of experimenting before we finally came up with a workable approach. My original idea was actually to shoot it at 24 frames per second — do the entire thing as a stage shoot, without motion control, by moving the puppets around manually while panning and dollying the camera in and out. I thought that by rehearsing it eight or ten times with pans and tilts and coordinating everything, we could just wing it and everything would come out fine. But that didn't work. It was just too hard to



For shots where it was not necessary to see the actors' faces, miniature speeder-bikes and riders were employed. The bikes — about two feet long — were fashioned by modelmaker Mike Fulmer, with accompanying riders about fifteen inches tall and articulated for movement. Numerous scenes in the chase featured these highly-detailed miniatures almost full-screen.

get everything to line up all at once. So we ended up having to motion control the camera head so at least the moves through the frame could be repeatable; and we motorized the model bike so the banking movements could be repeatable. Then all we really had to worry about were the puppets. And that's working out real well. We're shooting those at about six frames a second. Phil Tippett's doing a lot of the rod-moving; Tom St. Amand has done some also. Even / have — whoever happens to be around. They're really pretty simple to do because you're working at something close to real time. Usually we can do about three takes in twenty minutes or so.

I've been doing some of the basic motion programming myself, and you can get some really neat moves with these bikes. By having them constantly correcting up and down or left and right, and banking to avoid trees and shrubs, the look is really exciting. We're doing that to all the bike shots, and it looks like the flying is very dangerous. To create a greater sensation of banking, we rolled the camera on the bluescreen closeups of the actors so they rolled around the frame. This is the first time we've done this. Usually just the background rolls, and the actors remain upright. Rolling during the live-action really helps — something we discovered while shooting the videomatics.

16 December 1982 — RICHARD EDLUND

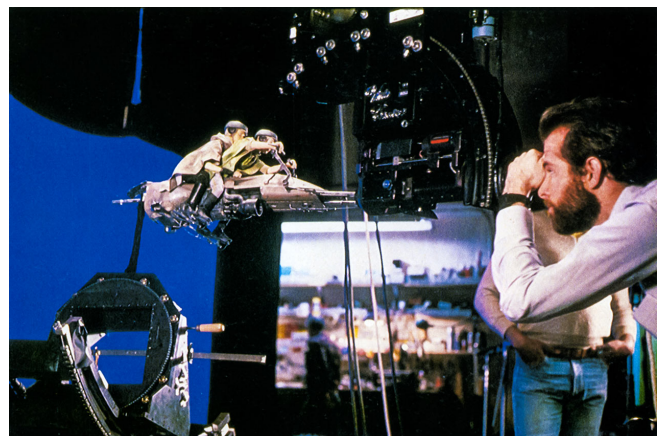
The rebel attack on the Deathstar is coming along. Better than a third of the sequence is in its final form right now. Of course, we're on kind of a logarithmic curve as far as the composites are concerned. It always starts out slow and then starts building up, and the curve gets steeper and steeper as the locomotion gets more and more furious. At the end of any project, optical always has a lot of pressure. The workload is enormous. Bruce is holding up real well, though. We've got our second printer in operation, so that certainly helps. It turns out that all the cuts and changes George was making didn't turn out to be much of an advantage to us in terms of time. A lot of shots *were* cut, but about a hundred more were added, so the overall number didn't really go down. The current tally on the whole picture, I think, is more than five hundred shots. I don't know how we're going to do it, but I'm sure we'll manage somehow.

We finished up the fire tunnel shots — two takes only — and they came out really good. Most of the elements for the rest of the chase are also finished. In fact, it's starting to get to the point where we're having trouble finding stuff for the cameramen to shoot. Almost everything that *can* be shot has been shot, but we're waiting on certain sets that aren't ready yet. Steve Gawley is still working on a really spectacular set for us. It's very large and very elaborate, and will only be in four or five shots; but it's for the climax of the sequence. In a way, it's a recapitulation of the asteroid sequence in *Empire* where the *Falcon* was flying through the canyons and then sails out into the big crater. Instead of flying out into a crater, however, we're flying through these tunnels and then out into this enormous reactor chamber — miles and miles across — which is the heart of the Deathstar. That's what they've come all this way to blow up. The *Falcon* flies into the chamber, still pursued by a pair of TIE-ships, and torpedoes the reactor core — and, of course, it explodes violently. Then they have to escape from the bowels of the Deathstar, and that's where the fire tunnel sequence comes in — they have to outrun the explosion. Then we have a shot where the *Falcon* is spat out of an exhaust port in the Deathstar by an enormous blast of fire. Anyway, we're waiting on the reactor chamber set. Steve expects to have it finished by the middle of January. Then we'll have to set up a laser unit,

since we're going to be doing some laser-generated environmental light effects near the surface of the big reactor core that's in the middle of the chamber.

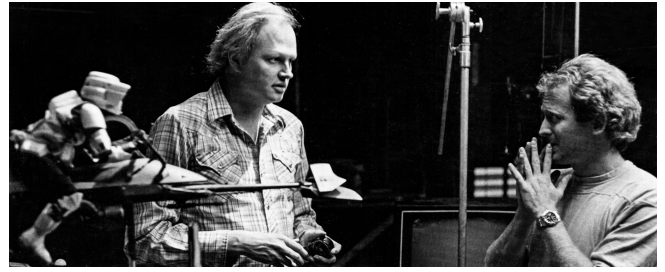


Once the basic effects scenes were storyboarded, ILM technicians produced a series of “videomatics” — quick-and-easy video enactments of the sequences which would prove most helpful in pacing and refining the complex interaction of live-action and effects. Making little attempt to conceal the perfunctory methodology, Ken Ralston, Don Dow, Joe Johnston and Dennis Muren walk their minute speeder-bikes through a hastily assembled “forest.”



Mike McAlister lines up a bluescreen shot through the VistaCruiser camera. The speeder-bike, attached to a special pylon, could be programmed to roll and tilt to simulate flying.

Another thing we're still waiting on is an enlarged section of the Deathstar that'll come into play when Vader's ship is destroyed. One of the characters in the sequence — we call him Mad Max — unintentionally kamikazes the control room on Vader's star destroyer, which then goes out of control and crashes into the Deathstar. For that, we'll be developing a mushroom cloud nuclear-type explosion on this enlarged surface section. So we still have several tricky shots left.



Muren discusses an upcoming shot with cameraman Robert Elswit.

Right now, we're in the middle of blowing up Jabba's barge. We had talked at one point about actually blowing up the full-size one that was built down in Yuma, but that discussion didn't go very far. You would have to have had an *enormous* amount of explosives, and it would have been a colossal mess. Besides, it was a better deal, financially, to have a salvage company come in and dismantle it and cart away the pieces. So we decided to go with miniatures. Charlie Bailey built the primary miniature, which is about five feet long and all decked out very nicely to match the full-size barge. We're shooting that in motion control right now — marrying it up to Wescam plates of the desert that were shot from a helicopter by Ron Goodman. The way the five-foot barge was built, a mold was extracted from it and from that we made up some other barges — one out of fiberglass, which is pretty tough, and some others out of a specially developed brittle composition material that we're using for the big explosion shot. We also made a few others, without the surface detailing, that were used in our tests.

Our original idea of shooting the explosion out in the desert has been nixed. The plan now is to shoot up on the roof of the stage — outside where we have a good vista and can use the natural sky and sunlight. Chris Evens did a big painting of the Yuma location which will go directly behind the miniature; and we had a guy drive up from Yuma with a couple tons of sand, which is now waiting up in the rafters of the stage. It'll be a pretty spectacular explosion. Every shot has its own particular needs. For this one, Thaine Morris — our resident pyrotechnician, master chemist, inventor, et cetera — has come up with some new secret formulas and a fancy new sixteen-channel sequence board. The main trick with miniature pyrotechnics is making them as slow as possible so you don't have to shoot at monstrously high speeds just to see anything. Otherwise, your miniature is here on one frame and gone the next. By sequencing a series of smaller explosions, the effect can be drawn out; and with the new board, we can work those things out precisely and time them right to the frame.

For the actual explosion shot, we'll be using the late Bruce Hill's high-speed camera that'll do 360 frames per second. For our testing, though, we have a 16mm Actionmaster that can pretty much duplicate the speed of Bruce Hill's camera; so that's good to test how the shot will look at speed. But usually there are other parameters involved, like making sure the miniatures and the paintings and the backgrounds all blend together, as well as working out lens problems and all those kinds of things. So I'll usually do one shot with my own high-speed Mitchell which runs at about 150 frames a second and which we can slow down on the projector. Between the two, we can pretty much work everything out. Then we schedule the shot and have Bruce Hill's cameraman on call. If it's a no-go,

we'll call him at five in the morning and say not this time. Otherwise, they fly up from Los Angeles, come straight here from the airport and set up the shot. It's usually pretty cut and dried. I've got the point of view all worked out with another camera, and all they need to do is just put their camera down and get ready.

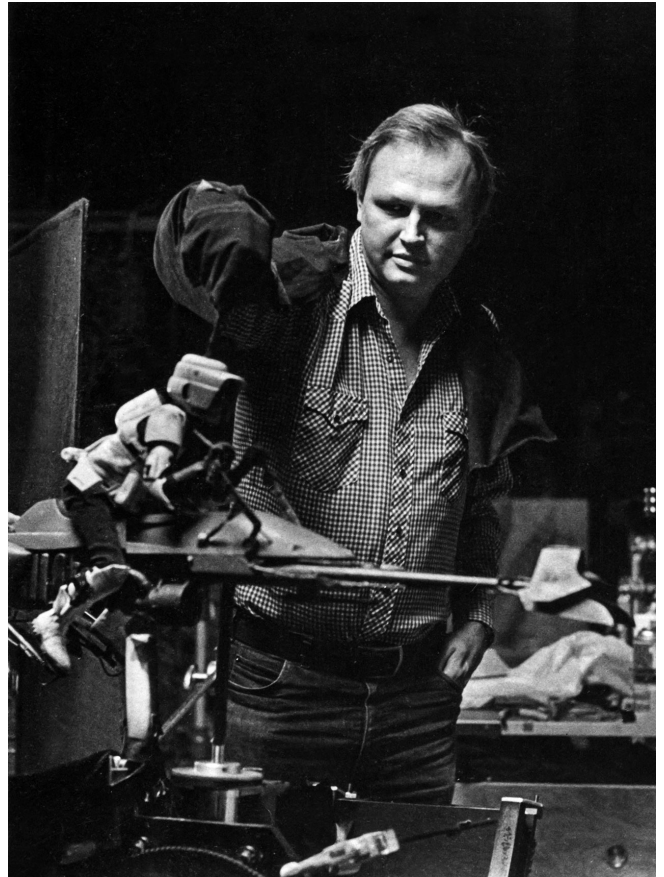
Anyway, we were all set to go yesterday — but it rained, so we had to cancel out. December weather in Marin is iffy at best, but things are complicated now by the fact that the weather satellite that all the forecasters use is apparently on the blink, and nobody seems to be able to forecast without it anymore. We've tentatively rescheduled the shot for next Tuesday; but the prognosis for next Tuesday doesn't sound that great either, so we'll just have to wait and see what happens. I felt it was important, though, that we shoot it outside. Especially when you're dealing with explosives, I hate to shoot inside because you need tons of light for a high-speed shot; and then when the explosion goes off, the smoke gets in the light and tends to dim the whole shot down. So it's much easier — especially with daylight exterior shots — to do it outdoors in bright sunlight.

In addition to the barge, there'll also be a miniature skiff — about a foot long — sitting right next to it. That one's destroyed when the barge goes up. Matted into the shot, however, will be a second skiff which races away toward the camera. Luke and Han and everybody are on that one, escaping from Jabba. That's a larger-scale model — about eighteen inches long — and it's being filmed separately under motion control, with a number of little stop-motion figures — about four or five inches tall — just to add some extra life. The skiffs will be used earlier, too, levitating and darting about as the battle goes on around the barge. Mike Fulmer built the skiffs, and Dave Carson did the figures.

So we're not exactly slacking off yet. It's interesting, though. At times, I'm incredibly busy; and at other times, I've nothing to do. It's an odd situation. On *Poltergeist*, I was busy *all* the time. Each picture seems to have its own personality.

13 January 1983 — RICHARD EDLUND

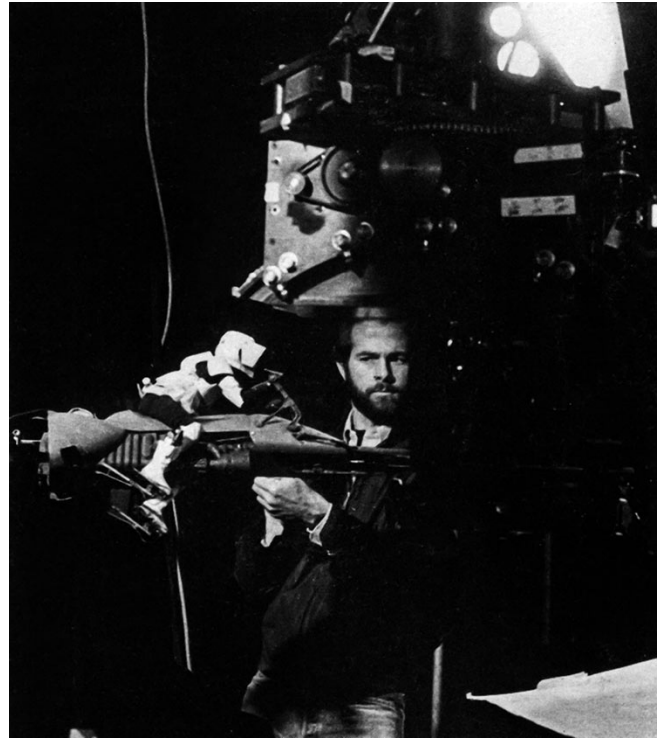
We're no longer working on *Revenge of the Jedi* — now it's *Return of the Jedi*, which I personally think is a better title. I've always seen the Jedi knights as being patterned after the samurai warriors with their strict Bushido code of ethics, and the Force as somehow paralleling the enlightenment of the Zen monks. And it seemed to me off-key that the Jedi would be after revenge. After all, revenge is not a particularly honorable pursuit, and I couldn't quite picture a true Jedi knight doing that. So I think that's a change for the better, even though it'll probably cause some problems since the trailers and the posters have already been finished with the original title. I imagine it'll cause a lot of talk and speculation among the fans.



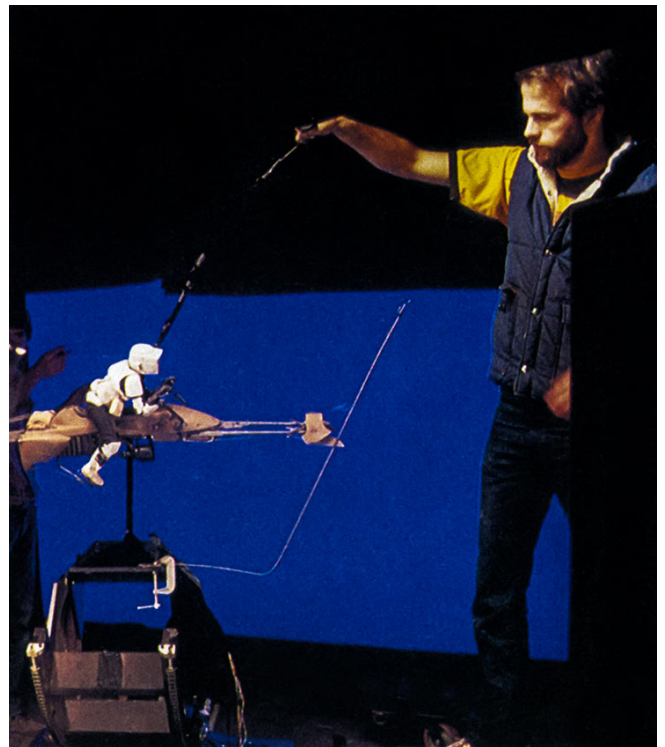
Dennis Muren manipulates a Mack rod running to the biker's head. Although the camera and bike mooes were motion controlled for repeatability, the riders were articulated manually during the shots — which customarily were photographed at six frames per second or less. The rods — one going to the puppet's head and one to its back — greatly simplified the photographic process, but had to be rotoscoped out of the bluescreen elements before the shots could be composited.

After waiting out the weather, the barge explosion was finally completed without any significant problems. We had two shots to do and four barges to work with — one fiberglass, that was finished only on one side and which could take quite a beating, and three of the fragile aggregate material that would be sure to come apart in an interesting way. Wesley Seeds was responsible for the casting on those. Our simulated desert was about twenty-five feet wide and about twenty feet deep, with a painting of the dune background behind it. The first shot was a fairly close view, with the barge just about filling the frame. Luke has just fired a laser cannon from the deck into the guts of the ship hitting paydirt, and the windows blow and big bursts of smoke appear on the poopdeck. We did that shot with the fiberglass barge since we didn't want the whole thing to blow, and that was shot at 360 frames per second with Bruce Hill's camera operated by Paul Nielson. Then we backed off and did a long shot where the barge is maybe a quarter of the frame width, or less. For that one, we used one of the other models, and Thaine Morris came up with a really grand explosion. Considering it was sort of a budget shot in that we didn't have a hundred-foot-wide painting back far enough to where it couldn't possible be hit by shrapnel or have a shadow pass in front of it, it came out great. The explosion is so magnificent that only on seventeen viewings will anyone be likely to notice a flaw.

In addition to the barge, there are also the two skiffs in each shot — one of which is larger in scale and will be shot separately under motion control and matted over the explosion. That's the one Luke and the others are escaping on, and that'll have some stop-motion figures on it that Ken Ralston's going to animate — as if he hasn't got enough else to keep him busy. But he's a good animator, and by having the figures sway and move around a little on the skiff, it'll help the reality of the shot. The second skiff was built to the scale of the barge. In the battle, Luke has already hacked all the monsters off it, and



Mike McAlister practices a manual puppet move, refining it to conform appropriately to the movement he has already programmed into the motorized pylon on which the bike is mounted.



McAlister manipulates the puppet against a blue screen.

they've fallen into the Sarlacc pit. So the skiff is just parked there next to the barge. In the close shot, it's mounted on a wire, and the wire runs between the skiff and the barge so you can't see it — although, if you're really astute, you can see the *shadow* of the wire. But I don't think anybody will pick up on that. Even George didn't mention it — Mr. Eagle-eyes. In the second shot, though, we wanted the skiff to tumble over. We didn't want it to sit there rigidly while the bomb went off next to it and blew the barge to smithereens. So we put it on a little wire tripod and had a small charge that was supposedly going to knock it out of frame. As it turned out, the charge didn't work; but the percussion from the big blast knocked the skiff over and it was just fine.

Then we jumped downstairs onto the stage for the high-speed shot of the Deathstar when Vader's ship reels out of control and crashes into it. That miniature was also about twenty-five feet wide; and since Vader's ship is very small in relation to the overall Deathstar, the surface had just a slight curvature to it. In the scene, Vader's ship comes into frame, penetrates and then the explosion goes off. The ship, of course, is being shot as a separate element and put in optically. What we had to produce was the explosion — which was another big blast with a mushroom cloud. We'd done some testing in 16mm a couple of months ago, so we had the shot down pretty well. We got that on take one. So, all in all, it was a pretty eventful day.

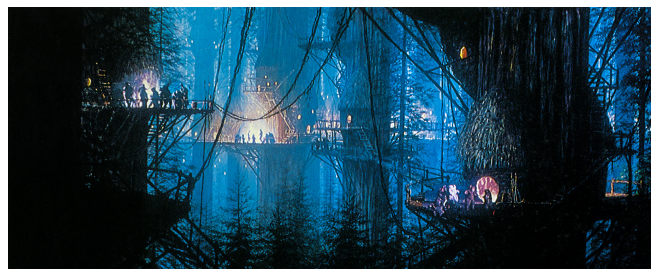
As it turned out, though, we had to go back for a second highspeed session, because on the first barge shot — the closeup — the wind direction changed on us just as the explosion went off and blew a big cloud of smoke into the shot, which obscured all our sunlight. We couldn't reshoot it that day since the fiberglass barge had to be rerigged; and we didn't have enough time to do that because the angle of the sun was critical to get the painting to match the sand we had shipped up from Yuma. So we rescheduled for a second day; and as long as we were at it, George had us go ahead and shoot the second explosion again, too. Everything went fine the second day. Since there isn't a VistaVision camera that will go fast enough to do this kind of work, the high-speed shots were done in 4-perf anamorphic, which has to be blown up to VistaVision to match the other elements, and then reduced back down and composited.

Today we shot two RARs — which are black-and-white move tests — on the skiff that will be inserted into the explosion shots. And Don Dow is now doing the motion control work on the other barge scenes — several shots of it traversing across the desert with several skiffs moving alongside it. Meanwhile, Dennis has been doing some high-speed work, too. He did a really nice glass painting with a foreground miniature — a radar dish explosion. It was a fairly simple setup, again with a grand explosion. One of the chickenwalker heads had to be blown up, too. He did that. Ken continues to be weighted down with the enormous number of spaceships which he's been shooting with his crew.

Meanwhile, the reactor chamber is about to go into place. It's really an amazing set — about twenty feet in diameter and incredibly complicated-looking. Unfortunately, we've lost Steve Gawley for a while. He's out with pneumonia, and will probably be gone for at least two or three weeks. He's a tough man to lose, especially at this stage of the game, but his guys are doing the best they can without him. Bill Neil has been finishing up the rebel attack at night. He'll be going back on days to shoot the reactor chamber, and we plan on starting that next week. Mike McAlister's now over on Dennis' unit shooting some ground battle footage of all the bikers weaving in and out of the trees.

George is having a lot of fun with that sequence. He's got a lot of cutting material, and that'll be a real centerpiece of the picture.

The matte department has just finished up another fantastic painting of the Deathstar docking bay, which has several plates of guys walking around doing this and that, and also a tilt-down from the spaceships flying around outside the bay to a plate in the lower right foreground that we shot in England — a lot of activity around the ships that are being readied for battle. They've also done some nice paintings for the forest sequence. The ewoks have little treehouse villages up in the redwoods, and those are being done as paintings — with torches and other little things being added to sweeten the shots. That's one of the real beauties of a good matte department. Naturally, we have certain things in mind whenever we shoot a plate for a matte shot; but when the job actually gets to the guys in the matte department, they'll often go way beyond whatever we might have thought at the time. Ideas develop and progress, and if you can give them enough time to develop the shot and rework it, they can go unbelievably beyond your expectations. With just a few strokes of the paintbrush, they can create whole sets or rebuild them. So that matte department has really turned into a great asset. The guys are young, but really talented; and they've been doing their utmost to turn out some great work.



A victory celebration in the treetop village of the ewoks. The three live-action areas were photographed as separate stage elements, composited onto a single piece of film, and then rear-projected into a Frank Ordaz matte painting.

The animation department has a lot of work, and it's increased in size. We now have a computerized Oxberry, and Jim Keefer has ten or twelve people working in the department — maybe more. They're doing laser blasts and shadows, lots of rotoscope mattes — the usual animation sweetening that tends to separate us from the other effects groups. It's a great department, and an extremely necessary one; but a lot of the work is pretty thankless. I remember telling Pete Kuran once how great his roto department was on *Empire*, and he said: "Yeah, but did you ever hear of anybody getting rich from doing rotoscope work?" Pete's not with us any more; but his own company, Visual Concept Engineering, is doing some good work for us — mainly laser swords.

We also have quite a number of outside opticals in progress. Pat O'Neill, for one, is doing some for us. Right now, our own optical department is at the point where they need to turn out six final composites a day, just to finish in time. So even the optical department's got day and night crews going, six days a week. You have to be really careful about long hours, though. After a point, you start getting into diminishing returns. People start making mistakes and wind up working twice as long to get half as much done.

Meanwhile, our production coordinators are doing just a terrific job of keeping tabs on everything and keeping things moving. Rose Duignan is our head coordinator, and she has three others working with her — Laurie Vermont, Warren Franklin and Patty Blau. They mother us and nag us and remind us to do this and that. We couldn't manage without them. Right about now, we're all starting to cower from the enormity of the task. We're just not far enough along to make anybody feel real comfortable. So it's long hours and six-day weeks until we finish.

17 January 1983 — KEN RALSTON

This place is a nuthouse. It never stops. The pressure is constant and it's getting worse every day — which is nothing new. It's typical of all these films. We'll wind up getting everything done in time — we always do — but it'll take a little extra push, and that's what we're into now. We have about six weeks left to finish up all the stage elements, and then optical and animation need the rest of the



Chris Evans prepares another careful rendering of the ewok village.



Only the top center portion of this down-angle view is real. The remainder is a Mike Pangrazio matte painting, enlivened with superimposed torch flames.

time to try and finish up. I have about two hundred things to shoot in six weeks. Richard and Dennis still have a lot of work, too. Needless to say, we didn't make our Christmas deadline for getting black-and-white temporary composites of everything with just the key elements. We didn't even come close. Right now, I have three still left to do. But we *are* hitting our deadlines for when they really need them. Each reel has a completion date that we need to hit so we can get a totally locked down cut that John Williams and the sound effects guys can get into and start working with. So far, we're okay as far as that goes.

Having to shoot just the key elements, though, has meant quite a lot of extra work for us. If I have a shot that needs a dozen TIE-ships, I'll go in and set it all up and shoot maybe two. Then, instead of using the same setup and lighting to put in the other ten, I have to tear it all down and start over from scratch with the next key elements for a whole new shot. Later, we'll have to go back and pick up the other elements. So it means a lot of duplicated effort and wasted time, but there's really no other way we can go.

We're also doing a lot of changing around on some of the shots, which is partially a result of George's recut and also of the way the whole project was approached. In the very beginning, George decided to turn Joe Johnston and George Jenson and all the storyboard guys loose and just have them come up with all kinds of ideas. He didn't want any sequences — no specifics. He wanted big extravaganza shots and small shots. He wanted spaceships doing all kinds of things. Then he took all of this unrelated stuff and made sequences out of it, even though there was no inherent continuity and each board was different from the next. Then the storyboard artists went back to work and began refining the sequences. The problem was that we had to start working with those original storyboards, and unfortunately there wasn't enough information then to really do the shots right — which is coming back to haunt us now.

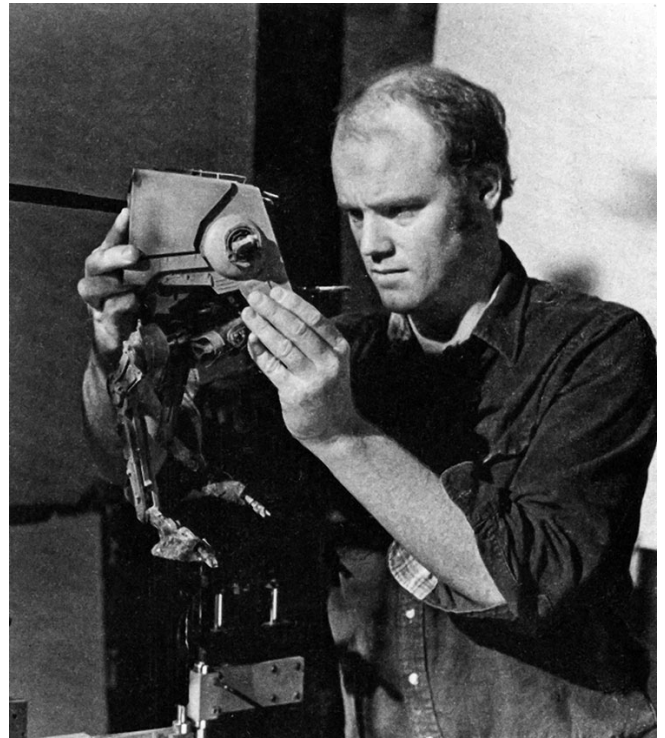
When the sequences got changed around, it affected a lot of what we'd already begun shooting. A shot that was twentieth in the space battle sequence might now be in the fiftieth position, so the shot that came before it — maybe a TIE-ship flying around and blowing up — is now a cruiser with an X-wing. So George would say: "Okay, then, drop the TIE-ship element and whatever other elements don't make sense anymore, and we'll stick in *these* ships." So we're constantly finding ourselves going back and replacing certain elements in a shot with other elements in order to maintain continuity from shot to shot. Even in the space battle, which is totally insane, there are little tiny sequences within where you have to follow a certain ship around. It might have been an X-wing in the first cut that got changed to a Y-wing in the second cut and then maybe to a TIE-ship in the third. So it's more than just dropping shots. It's also juggling around the existing continuity. That's thrown me off a bit, and it's one of the things that's gotten us backed up.



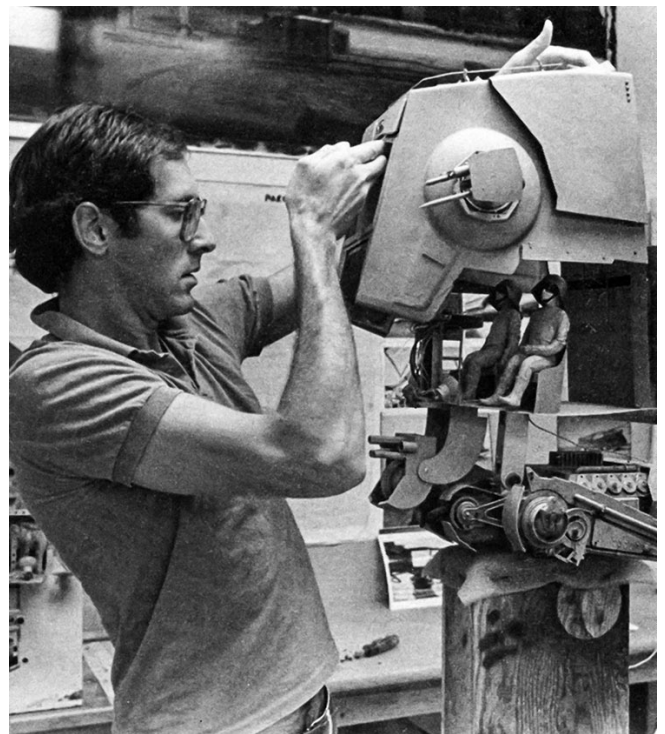
On a mission to destroy the ground-based force field protecting the new Deathstar, a small rebel force — aided by ewok allies — engages in a skirmish with Imperial troops in the forests of Endor. Highlighting the sequence was a clash with a number of two-legged scout walkers. One, parked outside the Imperial compound, was constructed full size as a set piece.

One of the ones I haven't even started yet is the shot where the X-wings come down through the double layer of TIE-ships and everybody's firing at each other. That's probably the toughest shot in the show — for me — and I've kind of put it off until last because I wanted to get all this other stuff out of the way, since once I start on it, that camera will be tied up for three solid weeks. I want everything figured out so carefully that there'll be no guesswork. We'll just walk in and do it. Otherwise, we'll never get it done. As it is, we'll probably have to simplify it a bit. The way the shot's been designed, there are some aspects of it that are going to be so hard to pull off that I don't know if we'll have the kind of time we need to tweak it out. In any event, we'll have to make it just as good as we possibly can, because it's one of those shots that George really wants to be a show-stopper.

George is asking for some incredible stuff — a lot of which involves adding things to scenes that, from an effects standpoint, weren't shot right in the first place. Dennis seems to be getting the bulk of that since he's the one who's working most closely with live-action plates. George wanted to put a chickenwalker into this one hand-held shot that was moving all around — which meant hand-drawn roto mattes and plotting the camera moves so that the background elements and foreground elements would all lock into that plate. Horrendous stuff! There'll be a bunch of stormtroopers lying dead on the ground and he'll want all but two of them painted out. Then, over on the side, we'll put in some trees to hide this prop that doesn't make sense anymore. Some bikers are sitting in the scene; but you can see the supports on their bikes, so you have to paint the supports out and maybe add some other bikers flying around. It's just unbelievable some of the things George is asking for. And what's even more unbelievable is we're doing it — at least in a lot of cases. We're trying anyway. But even George Lucas can't always have everything.



The moving walkers, however, were rendered in miniature. Phil Tippett makes minute adjustments to one of the walker puppets — which were shot bluescreen using ILM's "go-motion" technique and then matted into the live-action forest plates.



Modelmaker Paul Huston slides the head piece into position on a larger version of the walker used for a number of high-speed shots.

For now, though, we're still trying to give George whatever he wants. But it's rapidly coming to the point where we won't be able to do that anymore. In fact, in two days George leaves for London so they can start scoring the film. That's why we're rushing through all these black-and-white cuts, so everything makes sense and John Williams can figure out what's going on. Once the scoring's done, the picture can't be changed anymore — at least to any significant degree — which is actually a blessing for us. Finally, we'll have exact frame lengths on everything instead of having to shoot three or four times the length of each shot because we're not sure how it's going to be cut. That can make a big difference when we're shooting. Depending on the subject, some of the shots — like some Deathstar shots or shots of Vader's ship — can take twelve or fifteen hours for one element. For instance, the other day on the Deathstar we were shooting at 64 seconds per frame on the light pass! On a 300-frame shot, that takes forever. Sometimes it's tough just keeping awake.

We're doing some really neat things with explosions on this show. In the past, most of our explosions have been matted in; and so, for the most part, the shots were static and locked off. This time, we're working explosions into shots where both the ships and the camera are moving. We're trying a lot of different techniques, but one of the best is where we shoot a separate explosion pass on the ship. Say we have a shot of Darth Vader's conning tower, and we're moving away from it as it explodes. First we shoot our normal light pass on the ship, with no explosion. Then the camera is put back in its start position and we run through the exact same move again — only this time, we shut off all the lights, place a reflective card where we want the explosion to be, and project our explosion which we've shot specifically for this onto the card one frame at a time and rephotograph it. We've done a lot of that and the effect is really nice. We have one shot where we're moving away from a star destroyer — as if we're looking back from a ship that's in front of a couple other X-wings — and one of the big domes on the ship blows up with a couple of giant explosions. It looks great! It really puts the effect in the shot and makes it much more believable. It's also allowed us to put a lot of little explosions on ships while we're panning around. The only thing is, you have to be careful to make sure the projection plane doesn't get too oblique. Otherwise, it starts to have a very funny effect.

We're also doing some high-speed explosions where we're blowing up actual TIE-ships and X-wings and things. Those we can rig with explosives and detonate as they fly down towards the camera on wires. We've even shot some trailing balls of fire that we're supering into certain shots. They look almost like comets and are done rather simply by coating rubber balls with a chemical which gives off an interesting flame. We'd drop them from the ceiling — pitch black — and shoot them at different frame rates, from 48 frames up to 72 frames a second, with different lenses and from different positions, just to get a backlog of stock explosive things we could plug into various shots as we come down the line. The idea is to have things going on everywhere in the frame — mayhem in every shot.

Even though we all have our own sequences, there's a certain amount of overlap. Richard is doing some of the high-speed work. That's kind of his speciality. And I've been helping out a little bit with some of his stuff — I guess because I'm the last puppet animator available. He has some shots in the desert sequence where he's got some model skiffs floating around above the sand, and we're adding some stop-motion people just so there's a little activity on board the things. That takes a lot of time, but there are three of those shots that they really need to finish off one of the reels. Plus

they're being shot on one of the cameras I've been using, so they're holding us up as far as my finishing. So we're trying to finish that up as quickly as possible. Once those shots are out of the way, we'll probably go back to the space battle, and then hit the skiffs again later on.

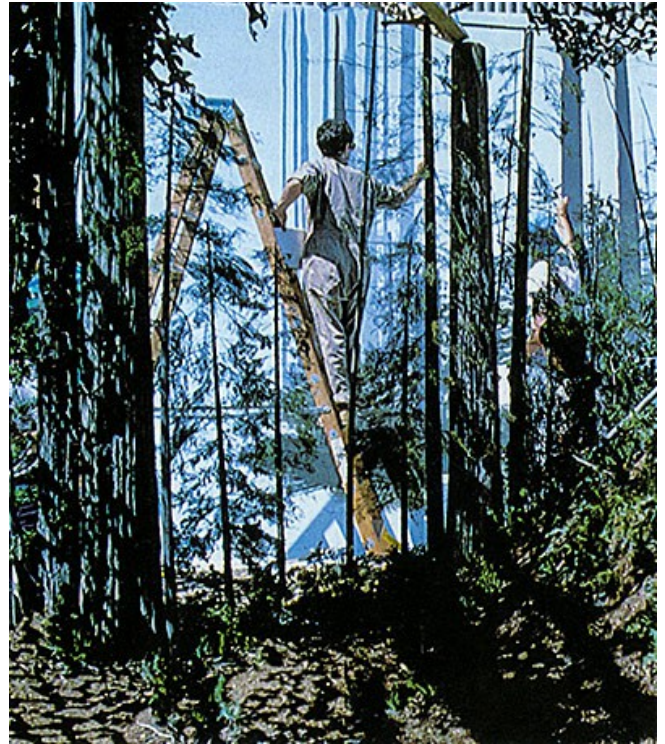
Dave Carson and Dave Sosalla sculpted the stop-motion characters — and painted all of them, except for about three which I did. One of the skiffs has about seven or eight of them on it; but in terms of work, that's a bit misleading, because it's not like I'm animating every one totally carefully. You can't put too much effort into those things because, for one thing, we don't have the time. But also, because of the composition of the shots and the fact that the skiffs are moving so fast, it would be lost anyway. We learned something on *Dragonslayer* which was quite curious. I'd program the dragon flying around, doing whatever move he was supposed to be making. Then we'd go back in and do the most beautiful, subtle animation you'd ever want — and you couldn't see it! It was like it wasn't there at all. We had to overdo it just to see it, and we were nervous half the time because some of the moves were so big. But that's what was needed. And it's the same thing with the skiffs. We're shooting against blue, and not even all of the figures will have movement. But the ones that do will be bold and rather overdramatic, just so your eye will catch a little activity while the thing is flying around. Otherwise, you wouldn't be able to see it at all and it would look pretty lifeless. Actually, the stop-motion has been kind of a nice change of pace after the seemingly endless motion control shots I've been doing.



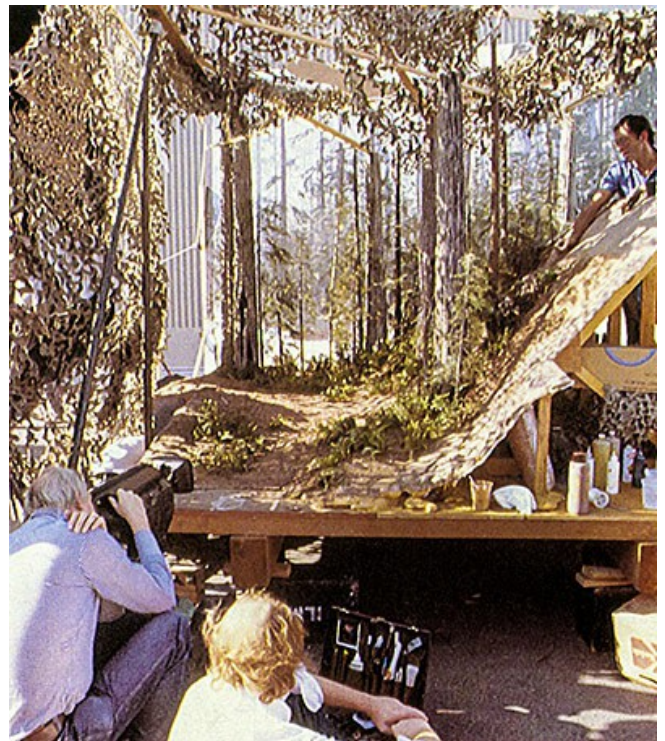
Supervising stage technician Ted Moehnke and pyrotechnician Thaine Morris dismantle the crushed walker head after a high-speed shot in which the ambulating machine falls prey to an ewok boobytrap.

It looks like we're going to be starting a night crew six days a week instead of just five. Richard still has a major sequence to do — the reactor chamber for the end of the film — and once that miniature is finished, it's going to tie up one end of one of the cameras for probably three or four weeks. That's three or four weeks we won't be able to use it for shooting fighters and other stuff. So we're really pushing on those. There's still a lot of highspeed work going on, and a lot of chickenwalker shots. Dennis today shot a tree falling on top of one walker, crushing its head and blowing it up. We saw an RAR on that, and it looks really good. Optical is starting to feel the last-minute crunch. They're really pumping stuff out now; but in order for them to finish in time, they have to turn out six final composites a day. That's a lot — especially when you consider that if they have a problem one day and only get out four, then the next day they have to do seven or eight. It wouldn't take too many problems for the whole thing to get totally out of hand.

We're just about to finish up the last of the Deathstar shots — which will be a blessing. There's been a lot of those. And lots of ships. Some of them are really neat, and a joy to work with. Others, I just don't like at all. My favorite is Darth's shuttle. I really like that one. Then there's the rebel cruiser. That one I absolutely hate. It's unlike most of the *Star Wars* designs in that it's bumpy and soft-looking — kind of like a Moebius drawing. I think George must have just wanted something a little bit different. It is interesting, and there are angles on it that look terrific. But there are other angles that must be shot just to tell the story where it looks painfully bad — and there's really nothing we can do but shoot them. We've got one ship that's still being built, so we're waiting on that — which has been kind of a pattern. The model shop finishes one, we grab it and shoot a few scenes with it, and then it goes into storage because we don't need it anymore. Then, quick, build another one.



A miniature forest set, complete with painted backdrop, was constructed for a scene in which falling logs topple a walker.



Shooting outdoors for natural lighting, Dennis Muren prepares for a shot of the logs rolling down a steep incline. Camouflage netting draped over the set simulates the lighting conditions in an actual forest. For this shot, the

Every day, of course, we have dailies; but once a week we have weeklies, where they show everybody in the place the comps that have been done — because not everybody gets to see them during the week. Last week, they showed a black-and-white print of the whole space battle sequence, with all the effects up to that point. After being so close to all the little nitpicky aspects of it for so long, it really gave me a chance to see everything in a different light — and it was great. I could relax and watch it, and it was spectacular! I was really happy with it. And it was a morale booster for all of us — which is really neat, to have everybody as excited about it as they are, even when we're all worked to a frazzle. I don't know how George does it, but this film is going to do it again. It's a two-hour roller coaster ride and I have a feeling everybody's going to go crazy over it.

go-motion walker was photographed separately and
Phil Tippett used it only for the high speed sequence
and bluescreened into the setting.
The reason for this was that it was actually falls over.



Phil Tippett at work on the go-motion walker set. The computerized camera controller in the foreground records and plays back the principal rod-actuated puppet moves to create a smooth non-strobing film image. Minor articulations, such as recoiling guns, are achieved manually between frames.



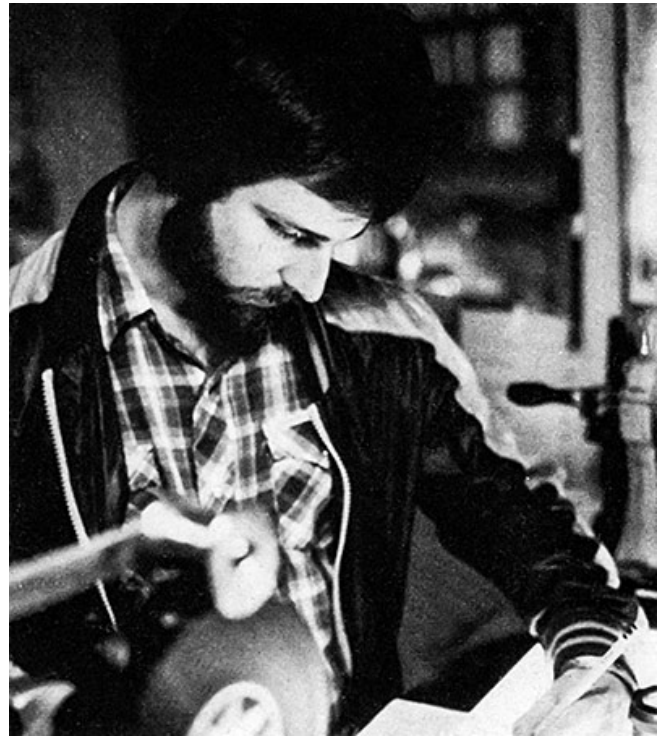
Animator Tom St. Amand adjusts the scout walker on its go-motion rig. Miniature trees, not actually in the shot, were used to cast appropriate shadows on the model.

1 February 1983 — DENNIS MUREN

The bike chase is just about finished, at least the stage work. Bob Elswit finished up the side views in about six or eight weeks, including some time we spent working out the bugs. Mike McAlister, meanwhile, has been doing the going away and coming toward the camera shots. Virtually the same hand moving technique is being used on these, except they're being done on our other, longer track. For the side views, the background footage was mostly blur and so we didn't have to worry too much about locking the miniatures into the plates. But for the Steadicam front and rear views, where the bikes are flying ahead or behind you, we had to take care to be sure that the miniature bikes didn't look like they were just pasted onto the scene. The key to that was plotting out all the bumps and jiggles in the Steadicam plates and then incorporating those same bumps and jiggles into the model photography. I did that by plotting the background plates a frame at a time on a pin-registered VistaVision Moviola and then feeding that information back into the motion control system so the camera would shake just the same as the plate. On top of that, we add the camera moves while playing back the shake. So what we have is a basic shake program combined with a pan and tilt program that moves the bike through the shot. It was a very tricky electronic problem, and Jerry Jeffress and Kris Brown made it work. The shots lock in really well — at least as well as can be expected by just plotting on a Moviola. Without it, you can really see the difference.

There's a couple of bike shots in the trailer — without sound effects — and it was a surprise to all of us that they just don't work without sound effects. It's real apparent that something is wrong — like you're on a magic carpet or something. So it's been decided not to have music during that sequence — just engine roars.

We're starting to see a few of our composited walker shots, and they're looking good. The big four-legged walkers we used in *Empire* were done with stop-motion; but those were supposed to be big and slow-moving, and so standard stop-motion was just fine. In *Jedi*, though, we're using the two-legged walkers, which are only supposed to be about twenty-eight feet tall and are a lot quicker moving than the others. So we decided to use go-motion and do everything with bluescreen. George was surprised when I said bluescreen, because he liked the look we had in *Empire* with the full sets and the painted backdrops. But that technique is very expensive and should be used only when necessary. Also, you can tend to overdesign a scene with that approach. You can work on every aspect of it until you get it perfectly composed and perfectly lit — and before you know it, it doesn't fit in with the rest of the picture anymore. When a film's shot, it has its own look. If it's done on a



Optical supervisor Bruce Nicholson. The ILM optical department composited a significant majority of the 942 effects shots in Return of the Jedi.

long schedule, where every shot is scenic, then it's going to be beautiful. If it's an action picture like *Star Wars*, though, it may have a very different look. For one thing, every shot isn't likely to be perfectly composed and lit — and if you intercut effects shots that *are*, they're going to stand out. That was one of the problems we had early on with *Dragonslayer* — our first tests just jarred you. We were out there trying to duplicate *King Kong* or something — but *King Kong* had a totally different look. It was the same situation with *Jedi*. I wanted to come up with something a little bit rougher and more natural-looking — something that might have been shot by a crew under pressure when it's getting near the end of the day and they have to just put the camera down, point it up and shoot. By blue-screening it, we could use real-life plates and shoot pretty quickly. Our only problem might be matte lines. I remembered shooting a bluescreen test with walkers on *Empire*, where we were dealing with bald skies and light snow, and any little trace of a matte line really showed up. But in *this* situation, we had a forest environment with alternating patches of darks and whites and greens, with all sorts of little clumps all over them, and I figured we could get away with it. We did a test and that proved to be the case. So we approached the whole sequence with that technique in mind, and it's working very well. With go-motion, there isn't any strobing, and we're getting a lot of shots done quickly by repeating some of the same basic walking programs. But what's most important, they cut right into the rest of the film.

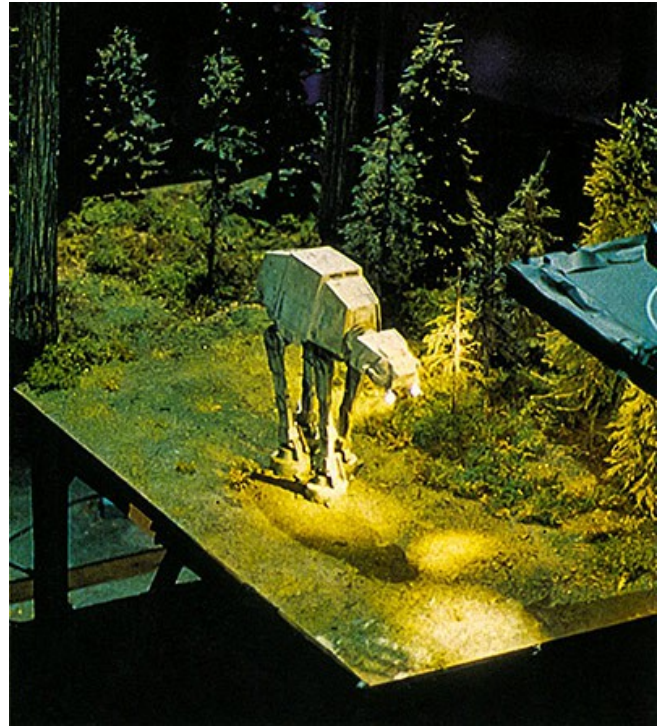
Not all of it's real simple, though. We're doing some pretty complex stuff. From the tons of plate material we shot, George is picking shots and saying: "Let's stick a walker back in there." So we'll shoot the walker, and the roto department will make sort of a matte of some fems or something in the foreground that'll cut off the walker's feet and make it as though it's back in the shot somewhere. Plus we're also putting walkers into a lot of shots that aren't locked off. Whenever we do that, we have to plot the movement in the plate and then incorporate it into our motion control program for the puppet. We had a couple incredibly long pan shots — like 90 degrees — and we'd look at them and say: "Nobody would do a shot like that. We'd be crazy to try a shot like that." But then we'd project up the plate, plot the thing out a frame at a time through the camera, and then play it back with the motion control on our model move — and it works! That's what makes this work so exciting. One shot's a big pan to the right, so what we did was walk the walker to the left. That way, if it's off a little, you don't see it. After all, there's no point in complicating things and possibly having it not work. But then another one that George picked after that was where it's locked off and you start panning to the left. On that one, he wanted the walker coming right toward the camera — so if it's drifting at all, you'll see it. We did that once; but it still needs to be a little bit tighter, so we're going to redo it. Then there're other shots that we're doing tilts on — just slight tilts as the walkers come forward. Those we're doing by shooting the shots without tilt and precomping them in 8-perf — using the full height of the VistaVision frame. Then we're going to go in and redupe that, tilting up optically from the bottom of the frame to the top. We have another *horrendous* shot that George insists that he wants. It's right after one of the walkers has been blown up. You see its head flying apart in a high-speed closeup, and then we cut to a shot of it standing there — with its head gone — and some ewoks in the foreground turn around and look back at it. The problem is that the only shot George could find where the ewoks stop running and turn to look back has a tilt on it. The walker's supposedly been hit and blown up, so it can't rock. It just has to stand there, smoking. So our tilt has to match exactly. We can't cover it up by having the walker moving around. We'll be starting on that one within the next couple of days.

I developed the basic lighting approach for the walker sequence, and Mike Owens and Dave Fincher have been setting up the shots and shooting them. Tom St. Amand is doing the go-motion programming for the walkers. Phil Tippett did the early programs, but he's since shifted over to the Rancor pit creature. We're right in the middle of that now. Phil designed the Rancor creature originally with the idea of doing it stop-motion or go-motion. But then George suggested making it the most elaborate man-in-a-suit monster ever. By doing it that way, we'd have more flexibility — and we wouldn't be stuck with a stop- or go-motion situation where it would take months of camera time. Frankly, we weren't that crazy about the idea in the beginning. We've seen that kind of stuff before and we know what it looks like. But then we started thinking about what we could do if we had the time and the money to really build the neatest giant suit thing ever. In the end, Phil redesigned the creature so we *could* get a man inside it, and what we eventually came up with was this big lizard-like creature that took three people to operate — one inside and one on each arm — with elaborate arm extensions and a complex face-moving mechanism. Of course, we were fighting weight and flailing arms and all the usual kinds of things, but we were actually getting to the point where we thought we might be able to work it out. When the suit was almost finished — around September — we redid the videomatics in a rough mockup of the set, just to get an idea of how everything was going to look. The suit was still pretty limited, but it *was* sort of starting to work. George saw it as pretty much of a dead end, though, and told us to go ahead and try it any other way we wanted.

Not to be doing the same old thing again — and rapidly running out of time and money — we came up with the idea of trying something like a Japanese theatre rod puppet. Since the Rancor sequence is largely in close shots and medium shots anyway, we went back to Phil's original design — which looked



An AT-AT patrols around the Imperial outpost on Endor — most of which is a matte painting by Frank Ordaz.



A small tabletop set, comprised of a few miniature trees and a portion of the landing platform, was all that was required to add a sense of three-dimensional reality to the painting. Phil Tippett stop-motion animated the four-legged walker.



more like there couldn't be a man inside it — and came up with a hand puppet concept that had rods coming out of the arms and legs so they could be operated externally. Phil and Tom built the thing with an armature inside for go-motion or stop-motion — just as an alternate capability in case it started looking too much like a Muppet. Dave Carson constructed a miniature cave from Norman Reynolds' blueprints for the full-size set, building it about six feet off the floor so the guys could get under it to work the puppet.

Joe Johnston , Dennis Muren , Ted Moehnke and Thaine Morris discuss the rigging necessary to explode the radar dish. Miniature trees surrounded the model, and Chris Evans provided a foreground glass painting. Aerial perspective was implied by placing a scrim — lit with blue light — between the model and the painting.

The footage is being shot at 72 and 96 frames per second, under an incredible amount of light to carry depth of field. The live-action stuff in the full-size cave was shot in a light smoke environment, and so we had to try and match that. Everything is very top-lit. There's a grating up above where Jabba and everybody's looking down, and so that's where the primary light source is. As I am trying to do with my other sequences, I wanted the camera to be operated as it really would be if the creature were actually *there* — which means unrestricted tilting and panning. At first, it was pretty complex trying to figure out how we could pan our camera around and have this glow emanating from above — *without* shooting the whole thing in smoke, which we didn't want to do because there were just too many shots and it's tough to be consistent from one to the next. So what I got for that is a piece of glass mounted in front of the camera at a 45-degree angle, reflecting a four-by-eight sheet of white masonite right above and at the same distance away as the set is. The masonite is illuminated by two lights — one just an overall light representing a flash exposure, and the other a narrow light that sort of fans down and falls off — like it was coming from the grating. Since the glass isn't connected to the camera, we can pan around on it and it looks very much like a smoky set. Then, beyond the Rancor, is a scrim which knocks it that much farther back.

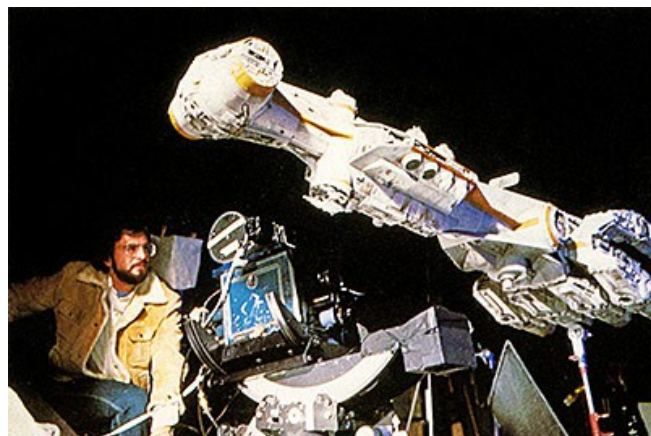
Since most of my other sequences are nearly finished, I'm doing the Rancor shooting myself, with Kim Marks assisting. When we're shooting, Phil has his arm in the puppet, operating the body and head. Tom St. Amand operates the arms with the external rods. We have to have black below the level of the arms, or else you see rods coming down and all that stuff. But the way the sequence is cut, we don't have too many of those shots. Those that we do have, we're just going to work out on an individual basis. Of the forty-five shots, there's only about eight of Luke that have to be bluescreened into the miniature set, and one of the Rancor that has to be bluescreened into the big cave. I haven't decided how to do that yet — we may have to do some roto work to show the whole creature. There are also six shots where just *parts* of the creature have to be bluescreened into the cave, and a few *Dr. Cyclops*-type shots with Luke in a full-size hand as it raises up in front of the Rancor's face. The rest are just straight POVs; and they're fairly tight, so even when you see the thing walking around, you're really seeing it only from about mid-thigh up. You don't miss anything, though, because it's all very claustrophobic anyway, and you're busy watching the face and the head as it's looking around for Luke .

The footage we're getting is just amazing. You're looking for matte lines and there are none. You're looking for stop-motion shake and there is none. You're looking for go-motion glitches and there are none. You're looking for a man inside, and you think maybe there *could* be, but not really. The camera's panning and tilting all the time and it's just like you're shooting a wild animal. You don't

know where it's going to look or what it's going to do — you're just trying to follow the action. A lot of times we're doing twenty or thirty takes — sometimes sixty or seventy — until we get something. But when we do, you can look at it and say, "I've never seen *anything* like this before." Anyway, we're in the middle of that right now. We've gotten twenty-three shots in just over two weeks, and the stuff looks wonderful. And in a way, maybe, it represents the kind of thinking that's going to have to be made to keep these pictures going, because they're so expensive to do. It's just unbelievable how much it costs.

Right now, the bike chase is nearly finished. We have about thirteen or fourteen more Rancor shots, and those should be done in another week and a half or so. Then there's about five more chickenwalker shots. But George is recutting that sequence now, so who knows? Sometimes he'll want changes that can be done simply by slipping the sync or flopping elements; but sometimes we'll have to go back in and reshoot. The ground battle has really turned into a major sequence. Originally, it was going to have fewer shots than the bike chase; but over the months, it's at least doubled in size. I'll also be doing a few shots for the end of the film when there's a big celebration and fireworks are going off, but we haven't even started on those yet. For the most part, though, the end is in sight — at least for the stage crews. Optical and animation still have an enormous amount of work to do — and so does the matte department. But every department's bigger than it's ever been, and everybody's working really hard to get the shots through without them bogging down along the way.

Fortunately, we have some really good people working for us behind the scenes, including Tom Smith, our overall general manager, whose extensive production background has been very valuable and necessary to the smooth running of ILM. We also have Rose Duignan, our head production supervisor on the show, and three production coordinators — one for each effects supervisor. Warren Franklin is mine, and he's been a great help in overcoming problems and obstacles.



Effects supervisor Ken Ralston, in charge of the massive space battle sequence, prepares for a closeup on the rebel blockade runner — in mothballs since its featured appearance in the first Star Wars film.



Cameraman Don Dow, assisted by Selwyn Eddy and Peter Daulton, tapes a space battle videomatic involving two TIE-ships. An UltiMatte video system allowed for instantaneous compositing of the ships against star fields or other backgrounds.

We're nearly finished with the reactor chamber. It's the biggest miniature set we've constructed for this film, and it's really quite beautiful. Joe Johnston designed it. The basic shape is a faceted cylinder, about sixteen feet in diameter, with a few facets left out so you can get the camera inside. Most of the surfaces are painted a dark metallic gray. In the center is a big orb hanging from the ceiling, with a cylindrical structure hanging down from that. Then there's kind of a fez-shaped form sticking up from the floor, and pair of electrode-type devices which flash and flare and have a kind of staccato gaseous energy leaking out and surrounding them. Lighting the set was no mean task. On the rear wall, there are a lot of tiny lights, which are always helpful for scale. Those were achieved by painting over clear plastic, and then scraping certain areas away and lighting them from behind with fluorescent lights. Then I had a number of little cannister-style light fixtures made and built right into the center of the set. Those bounce up off the orb and onto the back walls, producing a dark eerie lighting effect that changes subtly as you move around. We have a few other fixtures to provide fill light for the ceiling; and the floor is raked with a whole battery of 2000-watt quartz lamps, cut down with barn doors into thin slivers of light that pick up kicks off the surface detail on the floor. These are positioned around the outside of the set, and everything has to be just so in order not to get double shadows and streaks and things like that. Actually, there isn't a great deal of light in the set; but what there is is very efficient, because the walls are retroreflective — almost like front projection screen material. So the light comes up from below the central core and bounces from the orb onto the back walls, and then back towards the camera. The sequence is being shot with quite a wide lens and it's a little bit brighter in the center than it is on the edges, which helps give the feeling of vastness.

We gave some thought to shooting the reactor chamber in smoke, and I would have liked to have tried it. But the problem was that in order to do that, we'd have to smoke up the whole stage; and there's so much going on all the time that we couldn't afford to do that and monopolize everything. Within the time constraints we have, it would have been extravagant; and I don't think the look we would have achieved would have been worth it. As it is, we have that set on one end of our VistaCruiser track — the long track — and then at night Mike McAlister is shooting the bike chase characters at the other end. So it's sort of a yin-yang approach we're using in order to get two different camera crews working on the same camera system.

The energy plasma effect around the electrodes we're doing with lasers. It's a scanning technique we started tinkering around with on *Raiders*, in a couple of shots at the end where Belloq and Toht are standing up at the altar. Then we did some rather elaborate laser work on *Poltergeist*, in the bedroom "light" sequence and at the end where Teague gets zapped with shock waves outside the imploding house. Of course, that was a primary effect. For *Jedi*, we didn't want anything that complex. What we're using, essentially, is a nice little argon laser we're renting from Apogee — an electronic, pulse-fed galvanometer that spins a mirror at very high frequency in order to reflect a laser beam into a spinning cone of light. To get different patterns, you inject gases into the path of the laser, using a little electro-optical system to extend and contract the cone. The system we used on *Poltergeist* was computer-controlled, but we didn't feel we needed anything that involved on *Jedi*. In this case, it's a relatively minor effect and we couldn't afford to devote that kind of resource to it. Gary Platek did our laser work in *Poltergeist*. He wasn't available this time, though, so we pulled Garry Waller out of the animation department, and he and Peter Stolz are now shooting the laser

footage. Basically, they're using nitrogen and freon for the gases — each gas seems to have a somewhat different look — and with the argon laser they get a nice bluish color. That may be altered somewhat, but we won't be doing color separations and altering the color drastically, as we did on *Poltergeist*. The effect should be pretty interesting. At the beginning of the sequence, it's just around the electrodes — kind of bristling a bit here and there. After it gets hit by a few photon torpedoes, though, it really starts to pulse with this kind of plasmic energy.

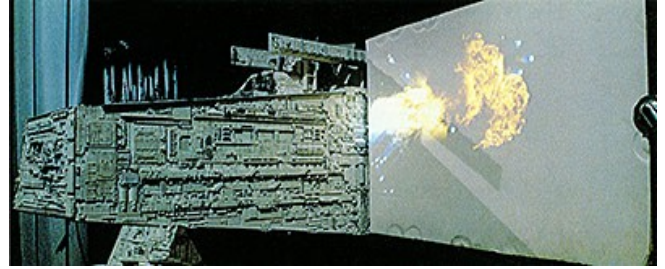
Right now, the laser testing is about finished, and we're just on the verge of getting some elements. With this kind of work, you generally wind up shooting a lot of material and then selecting from what you get. Once we've done that, we're going to have to rephotograph it a frame at a time — either on the Oxberry or on the optical printer — in order to introduce the proper camera moves, because in all the shots, the camera is moving. I suppose it might have been possible to shoot the lasers under motion control and match them exactly to the shot, but there's a fair amount of unpredictability to the effects themselves, and I think doing it that way would have been haphazard and cumbersome. So what we'll do is reposition and build our pans and tilts and so on into the material once we've picked it to match the scene. Then we'll just combine the two using our traditional matting techniques.

All together, there are eight or nine shots in the reactor chamber, and the whole sequence lasts about half a minute — if that. Half a minute doesn't sound like much, but if *Star Wars* has taught us anything, it's been that you can create a very definite impression in a couple of seconds, or less. The fact that the camera is moving very slowly gives you the illusion that the chamber is extremely large indeed — supposedly miles across — and the ships get very tiny as they fly towards and around this central core. It's quite impressive. We've got two or three shots left to do inside the reactor chamber, and we're pushing really hard to get them done by the end of the week so we can shoot the ships and the rest of the elements and get them into optical in time for Bruce to put them all together.

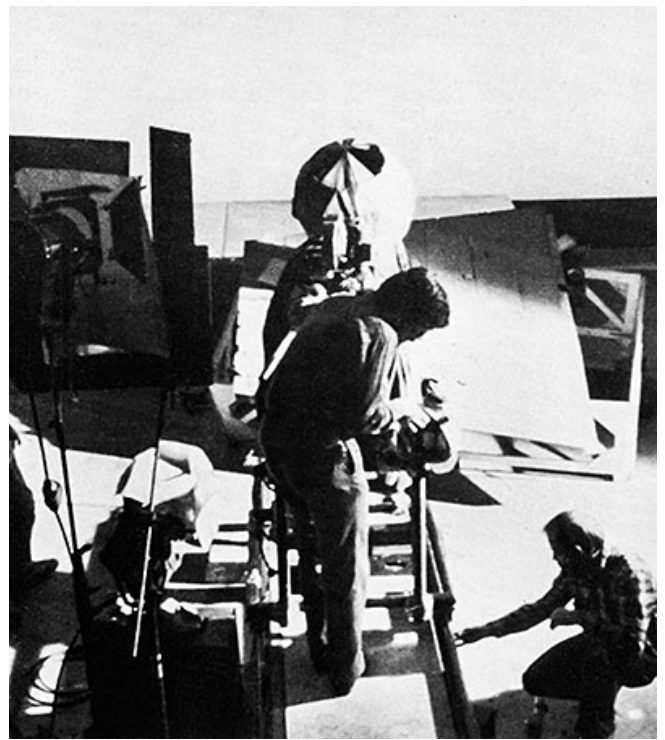
We're also still working on the sequence where Mad Max crashes his A-wing into Vader's ship and causes the star destroyer to lose control and crash into the Deathstar. The penetration shot with the mushroom-cloud explosion we've had for some time, and we've got the shot where the ship's been hit and is starting to heel over. A very large explosion is coming out of the bridge area and it's causing several others to go as well; and one of the big radar domes up on top has been blown away, and that's spewing flames. It's pretty spectacular. Between that sort of closeup of the bridge section and the long-shot of the surface, we need two more cuts of the ship continuing to heel over and dropping towards the Deathstar like an arrow. We've shot a number of elements on those — explosions and things that have to be projected onto the miniatures — and so they're pretty much ready to go. Don Dow will be shooting those tomorrow.

Earlier in the same sequence, we have a really nice shot of one of the ships accompanying Mad Max which gets picked out of the air on the way. To get that, we used a couple of standard X-wings that Wesley Seeds made up out of a brittle material that blows apart nicely; and in the scene, it looks like the ship's flying from the lower part of the frame up towards the center, and then explodes right in front of the camera. I shot that against a blue screen, using a three-wire suspension and the field recorder to keep the thing level in the frame. The model was actually flying in a big arc — about a thirty-foot radius — being dropped from the top of the stage and just whizzing by camera

with the three wires parallelogrammed in such a way that the angle of the ship maintained a relative flatness in relation to the camera. Then, with the field recorder, we could pan the camera to effectively eliminate the arc from the shot. Thaine Morris came up with a really nice bomb; and as the ship got about five feet from the camera, it was blown up by means of a photoelectric cell trigger. We had about ten guys working all day on the setup and got the shot off about three o'clock in the afternoon. We shot at 72 frames a second, with about five thousand foot-candles of light, and we got two great takes. We had a real scare, though, because the lab chewed up a foot of film right after the first take. You never want to believe that the lab has ruined your film — and it rarely happens — but they sent over this mangled foot of film and we felt for sure it was all over. Fortunately, everything was okay.



In previous Star Wars films, spaceship explosions were generally matted over the model photography, thereby necessitating locked-off shots. In Return of the Jedi, many of the explosions were achieved by placing projection screens against appropriate miniatures and then projecting the explosions on a second motion control pass.



Other miniatures, such as this enlarged section of a star destroyer conning tower, were actually rigged with explosives and detonated.

We've now got the skiffs shot for the big exploding barge scenes, and those have fallen into the maws of optical. So the elements are done, but the shots are not yet finished. We're still working on some barge elements for the earlier scenes where it's moving around the desert prior to parking in front of the Sarlacc pit. We're not going with my idea to try and rotoscope the full-size barge and give it some apparent movement by optically zooming and panning. We did some tests on that, and I think I could have gotten it to work — but it was vetoed. It was a cheat — no question about it — but every now and then you can get away with that kind of thing. George wanted it to move a little bit more, though, so we're going to paint the whole shot and have the miniature barge going in on the right, with just a sliver of the original live-action skiff shot over to the left of the Sarlacc pit. Then I'm going to have Terry Windell cel-animate some silhouettes up on on the deck of the barge, so it doesn't just sit there looking like a ghost ship.



The film's numerous pyrotechnic blasts were engineered by veteran powder man Thaine Morris.

We still have more skiffs to shoot, and a few flying scenes for the rebel attack. And scheduling is getting really tight now because we have to get composites done roughly in VistaVision so the animation department can step in and start sweetening the shots. Without some kind of a precomposite, they have nothing to work from — and they've got a lot more shots to do. In fact, the bulk of the workload still remaining has now shifted over to the animation and optical departments, and there's just a back-breaking amount of it left. The animation department has about a dozen people right now. Optical is up to eighteen or twenty — the most its ever been — and even that doesn't seem to be quite enough. Plus we still have a lot of material being shot on the stages. It's getting pretty scary. Everybody's starting to really feel the effects of the crunch.

16 February 1983 — KEN RALSTON

It's almost over. Everything is coming down to the wire. Already, the pressure is starting to ease up on the camera department. Some of the crews who have been working with me for most of the show are now over with Richard, because he has the most elements left. I think I've only got about five or six. Unfortunately, they're not easy ones. Nevertheless, it's hard to believe — we're almost done. It's a wonderful thing to get to this point. The model shop has let a lot of people go; they're basically finished. In a week or so, the stage guys are going to be gone. Animation and optical still have a *horrendous* amount of work to do in a very short amount of time. Animation's been doing a lot of stuff for Dennis, but now they're getting into the space battle shots and they're doing lasers and flak bursts and all those kinds of things. The way that's done is the key elements that need the animation are put into real simple precomps so the animation guys can line up their animation to the specific action. Usually, I'll sit down with Jim Keefer and whoever's actually doing the shots and we go over whatever it is I would like to see, and the pacing — and they take it from there. When animation's done, I follow it over to optical and work with them. So Richard and Dennis and I aren't

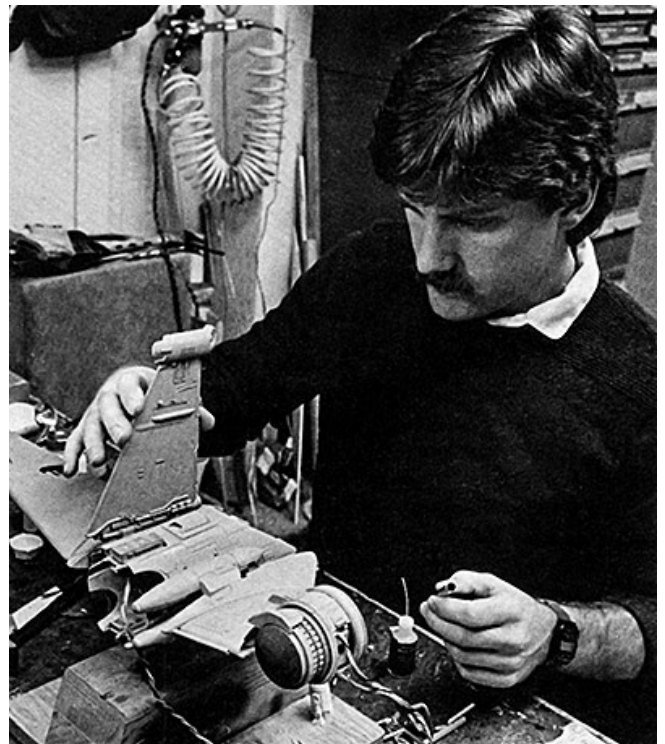
through when the stage work is finished. The pressure eases up tremendously, but we're still involved in every aspect of our shots — from the storyboards right on through to the final composites.

When we're done, one of us will go down to L.A. when they do the color timing, just to make sure they don't print the effects shots in some weird way. That's often a problem, because there are always certain shots that come up where the timers have absolutely no idea what they're looking at — so they don't know the colors, they don't know the time of day, they don't know anything. As a result, they're liable to print things in a very strange way. A yellow ship may come out purple, or the shot may be printed twenty times brighter than you wanted it to be and all the matte lines suddenly show. So we like to go down with lots of reference material — preferably stills or photographs of how things should look, just to give the guys who are controlling all of that a little input on how the whole film should look.

George just got back from England where John Williams has been doing the music. Everything is coming together very fast. Tuesday they start doing the finished sound mix, even though we're not done with the effects. Certain reels are finished and they'll begin working on those. Meanwhile, we'll be rushing to get the other ones ready. George is still making changes, but they're more minor now. Over the next several weeks, I expect that most of the shots will be fine and dandy; but as we're going on, there'll be parts of shots we'll have to redo to give him what he wants. Tonight, for instance, George called and said: "Come over quick. We're discussing one of your shots." So I ran over and met with him and Joe Johnston and Duwayne Dunham, who's George's main editor. The shot he was talking about was one where the Emperor is on the Deathstar and they're having a military parade of sorts — showing off because they're trying to impress him. Some ships are flying past a big section of the Deathstar wall and George wanted four of the interceptors to make a more obvious turn as they drop down through the different levels of the Deathstar. Our original moves were too subtle for what he wanted to express; and since it looks like we'll have the time, we're going to reshoot it. Also, he wants to add another fifty TIE-ships in the distance — which isn't as bad as it sounds. Those we're doing with photo cutouts, and we've had real good luck with most of the shots where we've done that. The main thing is, they have to be very small. Usually they range from one inch to about six inches long, and we put bunches of them on different panes of glass so they can move against each other. With different size cutouts, we can fake the illusion of depth, as though they're trailing off into infinity. And with movement, it's quite effective, especially since we have models working within that group also. The whole effect is so busy — and it's in the background, anyway — that there's no way you can discern what's really going on, especially with the amount of time you have to see that part of the shot.



On the ILM matte stand, Mike Pangrazio adds last-minute details to a rendering of the entrance into the Deathstar docking bay. Foreground miniatures, such as the gantry at left, were used in many of the Jedi matte shots so that slight perspective changes could be effected during camera moves on the painting.



Bill George at work on a B-wing fighter — a new ship featured only fleetingly in the space battle sequence.

Anyway, those are the kinds of changes George is making now — mostly little things that won't interfere with the sound recording because the main action and the timing are basically the same. Of course, there are shots where we can't change *anything*, because it's already just too late. George is a perfectionist, to a point, but you can't beat a dead horse. There will always be room for improvement. In fact, if you asked any of us, we'd probably say the effects are about twenty percent of what we really wanted them to be. None of them are perfect. But with the time we had, the best we could do is make sure we worked hardest on the parts of the shots your eye would definitely pick up. After all, most of the background stuff will go by and you'll never even notice it. You'll get the impression that something's out there, but if there's a minor screw-up or something's not quite right, you won't be able to pick it up — unless maybe you see the film thirty times, in which case you *deserve* to find a few things wrong with it.



Modelshop supervisor Steve Gawley prepares the blockade runner for a shot.

It's neat at this point watching everything come together, and seeing how Dennis' sequences cut to mine, mine to Richard's, and so on. And, of course how the effects cut to the live-action. The pacing is incredible — and so is the push. We're all pushing like crazy to finish it up. Even though most of the key elements are shot, we still have to go back and fill in the backgrounds, which is a lot of work. In addition to that, I'm working with Garry Waller and Peter Stolz on some laser photography for the Emperor's death pit. Tom St. Amand took over for me on the stop-motion skiff shots because I just couldn't get away from all this other stuff. In fact, I can't get a moment to myself anymore.

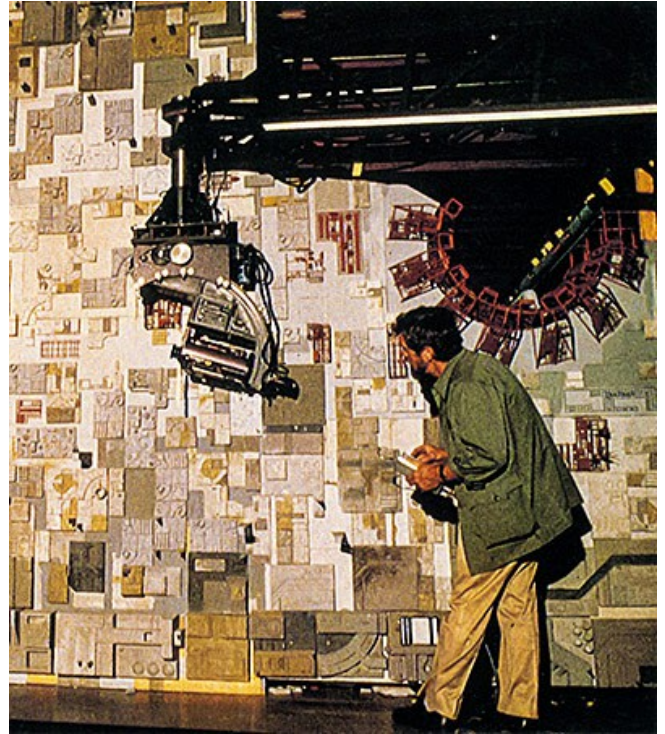
Everything's not *totally* serious, though. On every picture, we try to sneak a few weird things in. On *Empire*, we had a potato flying through the asteroid sequence. For some reason, we all felt like we had more freedom to do gag shots and things on that show. On *Jedi*, though, we really hadn't done *anything* until just this week when I started horsing around with some of the elements. So on the fleet shots, I've been putting in pictures of my tennis shoes, wads of gum — things like that. You'll never notice it, but it's kind of fun to fool around sometimes and see how much you can get away with. I have one sequence that's been cursed since the beginning of the movie. There's nothing particularly horrendous about it. In fact, it's pretty straightforward. Han and Luke and the whole gang are in a shuttle they've hijacked, and they're trying to sneak by Darth's ship toward the Deathstar without anyone noticing — and as they pass, Darth is sitting at the window wondering what's going on. I don't know why they have to go right by in plain view rather than sneak around behind — but that's the sequence. Anyway, for some reason, there were a great many conceptual changes, and every time George altered the sequence a little, a change in one shot would end up affecting the seven before it and they'd *all* have to be reshot. Then we had all kinds of technical problems. Speeds wouldn't match up, cameras would break down — things that only seemed to crop up when we did stuff for that sequence. Finally, it's going together; but it's like the whole thing was jinxed. It was driving me nuts! As my comment on the whole situation, I've started placing a human skull somewhere within each of the various elements. Ultimately, the sequence I'm sure will be fine. It's just never going to be one of *my* favorites. When it comes on, I'll go out for popcorn.

One of the things we still have to do is shoot the opening crawl. Believe it or not, George still hasn't written it! And the thing is, you sit there and you read it, and who cares — right? You just want to get through it and on to the opening shot. But shooting that crawl is actually one of the hardest things on these shows. The artwork itself is only about four feet long, and maybe a foot wide. The camera is real low to the ground and we use a tilting lens to eliminate a lot of the focus problems. It's like using a 4x5 field camera; we have a lot of control. But everything has to be lined up just perfectly. You can spend *days* running through tests. It'll look lined up by eye, but it always turns out just a little askew. You can't quite get to the point where it's perfect. And every little blemish shows up. Any little bump, any little movement of the camera is going to screw up this big 2000-frame-long take. Pure torture. Then, once it's done and the whole film is finished, the 'Flex crew will have to stay behind and spend another month shooting eight different language versions of the same thing.

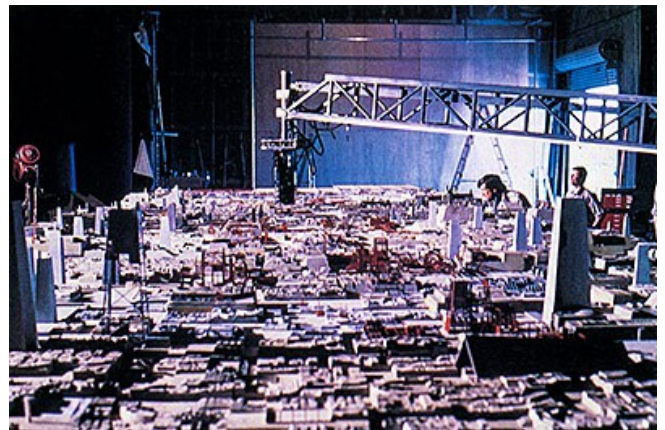
I was lucky enough to see the last three reels of the film where most of the heavy-duty action takes place. It has a really terrific feel to it. Nonstop mayhem and lots of nicely choreographed action sequences. I'm really anxious to see how John Q. Public will react. We have a couple trailers for the show — which basically show nothing, because George didn't want to reveal very much. And frankly, they're kind of lame. There's a certain edge they don't have, only because George was far too busy to do them himself. But people in the theaters are going bananas over them! If they're loving that, wait'll the film comes out. They'll go crazy!

2 March 1983 — RICHARD EDLUND

As of a couple of days ago, the stage work is finally finished. For all intents and purposes, everything is shot. The animation department is still busy with the sweetening process, as they always are right up to the bitter end. There's never enough time to do everything we'd like, so basically it's a matter of trying to utilize the time they have left to best advantage. Optical, of course, is swamped. At this point, only about three-fifths of the composites are in final form, and the closeout date is supposedly April 2nd. Bruce Nicholson is incredibly submerged. He has just literally thousands of rolls of film that he's dealing with. The matte department's got four or five paintings left — fairly tricky ones. The desert matte shots have been difficult paintings, and Frank Ordaz has been doing a lot of those. Originally, the matte department started out with about fifteen shots, and it didn't look as though they'd have a whole lot to do. But all of a sudden, they started turning out some really fantastic stuff; and as I expected, the workload increased. I think they wound up with forty or fifty matte shots in the end — some of which were extremely complicated.



Joystick mechanism in hand, Richard Edlund programs the ILM VistaCruiser camera to skim the surface of the Deathstar and sail into an open entry port. The footage would later be used as a background plate for the shot in which the Millennium Falcon and her pursuers enter the labyrinthine bowels of the massive battle station.



Edlund programs a sixty-foot low-level pass over the Deathstar, while cameraman Bill Neil observes.

As for me, I don't really have enough to keep me busy. I'm just kind of watching over what's going on — primarily with my scenes — assessing problems and making adjustments as they work their way through animation and then come up in due course in optical. Right now, we're working on blowing up the Deathstar, which is going to be a somewhat complicated little montage of effects. The Falcon has just escaped from the flames and Lando is flying towards the camera as the Deathstar explodes behind him — and we're using a technique that's

somewhat more sophisticated than the one we used for the *Star Wars* demise of the earlier Deathstar, which was just a matted-in explosion. What we did this time was shoot several passes on the Deathstar miniature with little lights that would blow out exposure-wise and illuminate certain areas so it would look as though there were some kind of explosion starting to build within. Then it just novas — and for that, we're using one of the large-scale explosions I shot at the San Francisco Armory during *Empire*. Basically, all this occurs in about a second.

During the final days on stage, Garry Waller and Peter Stolz finished up the gaseous energy plasma that radiates from the electrodes in the reactor chamber. Laser work is controllable to the extent that you can control the scanning pattern and the injection of the gases into the path of your laser, but it's still kind of a "happy accident" situation in a lot of ways. So you end up shooting copious amounts of film in order to get little snatches here and there. All you can do is try to control everything you possibly can, and then go for it. Line-up clips were used in the camera to position the laser patterns roughly where they needed to go in the final frame. Now Garry Waller is rephotographing them on the Oxberry to match the moves of the actual shots which have been plotted out for reference. Ken Ralston was also getting together some laser footage to incorporate into the Emperor's throne room. The master shot is a matte painting, and we now have a *Poltergeist*-style laser-generated energy form shooting up through a tunnel.

In the closing days, we also finished up the desert miniatures — getting all the skiffs to match up and levitate alongside the barge. That was relatively straightforward. Matching the lighting to the live-action plates was the main thing. It was kind of interesting. The desert is such a vast expanse of nebulous shapes that we found there was really nothing to give you a sense of scale, unless you put it there. In a way, that worked in our behalf because we could make the shot look four times as large as it actually was — or half as large — depending on what we wanted to put into it. So we had a flexibility with the desert plates that we don't often have. For one shot, though, we wanted to show a tiny little barge and a couple of skiffs way off in the distance. Since we only had one size barge — and that was fairly large — we realized that to shoot the miniature on stage would mean getting way back and shooting with an ultra-wide lens. To avoid that, we decided to try shooting still photographs on the animation stand; but that attempt didn't come out looking very good. It's a real subtle thing. Since the scene's in direct sunlight, you can't get away with much because everything is real sharp and crisp; and if something doesn't look quite right, it really points itself out. So Don Dow — who did all the motion control barge shots — had to get as far away as he could and just



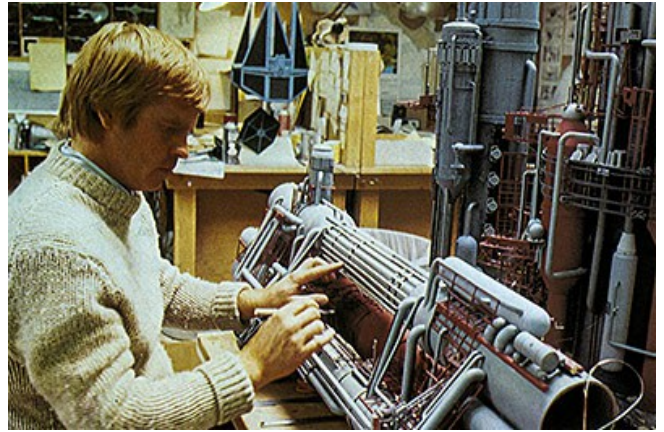
Thaine Morris rigged another major explosion on an enlarged section of the Deathstar. Optically combined with Wader's star destroyer, the final shot appears as though the giant ship impacts on the surface and explodes.

shoot the miniature. Then, since the barge had to fly into a shadow area, we ended up wiping together two separate shots that were lit differently. We had to do the same with the skiffs.

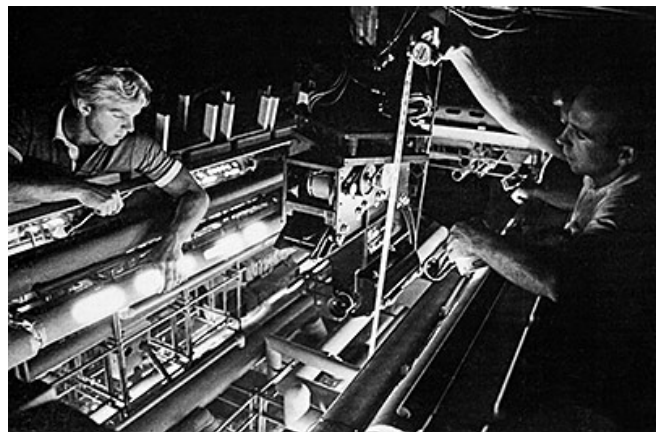
Don, in fact, is about the only one left still shooting on the stage. He's doing the main title and the opening crawl. A number of the guys have already left. The night crew is off, and only one or two day crews are still working. At the end of any film there's always a little thing here and there that needs to get shot, so we have a few crews still hanging around to take care of those kinds of things. Aside from that, though, things are starting to wind down. We even had a little "wrap" party a week or so ago — and despite the relief, there were elements of sadness. We are, after all, at the end of an era here. It's a finished job now. When this picture hits the screen, it'll be the end of the trilogy. And who knows what will be next? Or when? Of course, George has talked about making this a nine-part saga, but I don't think he's wanting to think too much about that right now. If he does go on, I don't believe he'll do it in the same way. I doubt that he'll ever want to do anything as complicated as this again, at least with regard to effects. The complexity of the shots in this film — the amount of elements and all that — I think, will set a quantitative record of achievement that'll probably stand for quite awhile.

30 March 1983 — DENNIS MUREN

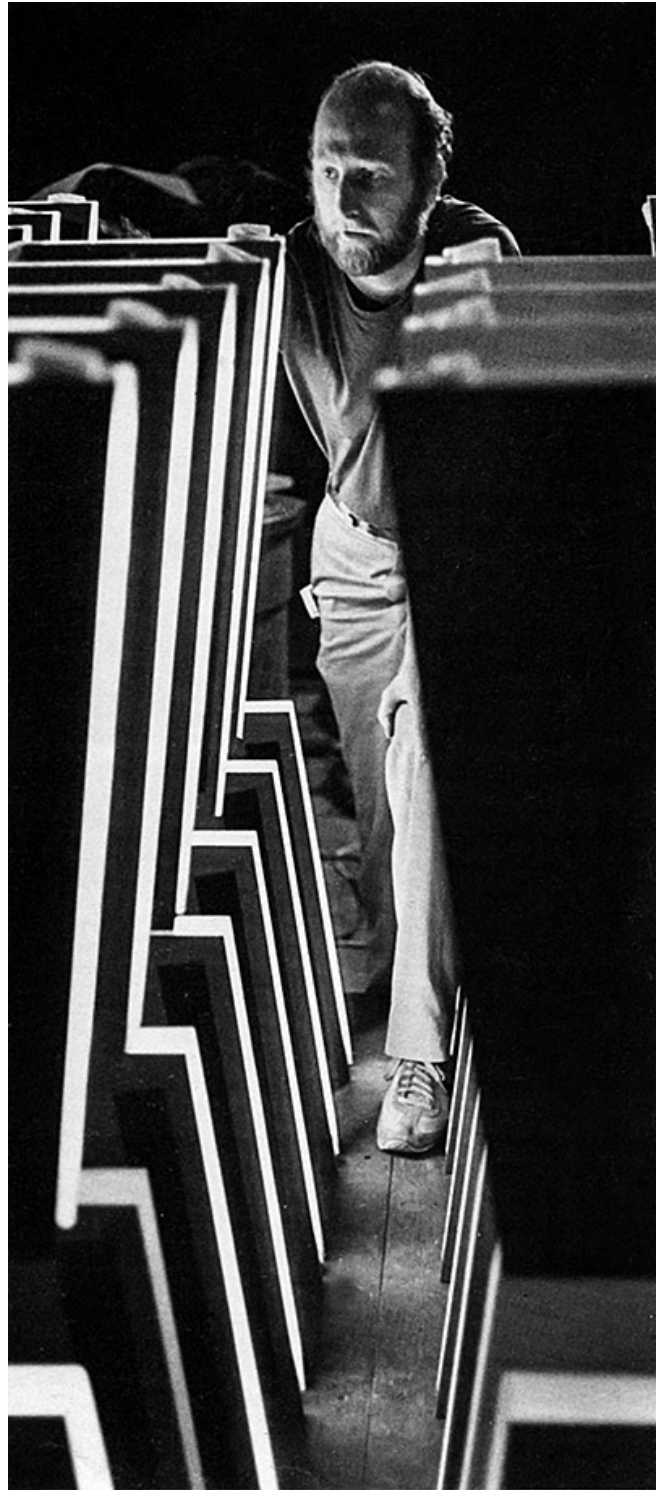
Our stage work has been done for several weeks now. Rancor finished up pretty quickly. I think we shot most of that in about three or four weeks — all of it with our hand-held puppet technique, which worked out really well. Phil worked the inside of the puppet — the body and the face — and Tom did the arms externally with rods. In fact, not only could he move the arms, but he could also move the hands and fingers by means of a cable mechanism that Eben Stromquist built to work them remotely through the back of the elbow and down the rod. David Sosalla was in there, too, working the legs and the feet. And the stuff is really like nothing you've ever seen. It's supposed to be a slow, lumbering reptile-type creature. It's not very bright and doesn't move very quick, so it's played with its arms up — sort of a Ray Harryhausen-type pose — ready to grab whatever's out there. We have drool dribbling down from its mouth and sort of slopping back and forth; and there's a chain hanging from one arm, with the interlocking links going back and forth in a way you could never do with total conviction in stop-motion. Most of the time you see the creature from about the knees up. I considered doing one or two go-motion shots, just so you could see the whole thing moving around in the cave. It would have been no problem, because the puppet was fully armatured — mostly hinges and swivels — and was built with that possibility in mind. But I decided against it. We'd have had to have done it bluescreen, and I was worried about what the matting would look like — having to matte the rods out and everything. If the cave had had a different look to it, we might have been able to do that; but it was pretty bright in there — with a certain haze value over everything — and I was afraid to interject one or two of those shots and risk blowing the whole illusion. You wouldn't have wanted too much of it anyway. It was a very close setting, and it would have looked awkward if we'd seen too much of the creature too often. Besides, the shots would have had to have gone through the whole building, and animation and optical already had more than enough to keep them busy, especially since the bulk of the space stuff — a lot of which has twenty or thirty elements — just started coming in during the last six weeks. Using our hand-puppet approach, the shots were finished when they came out of the camera.



Modelmaker Scott Marshall constructs a section of tubing to be used in the *Deathstar* tunnel chase.



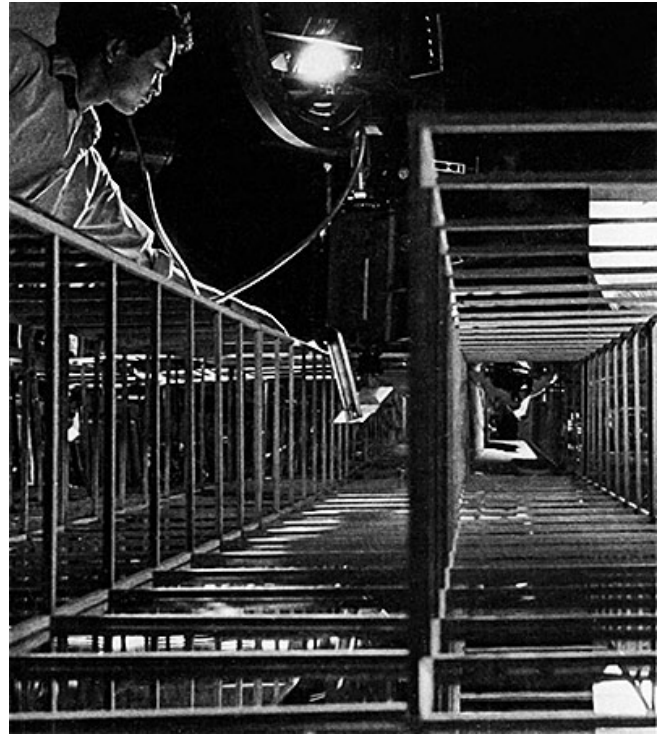
Stage technician Dave Childers and assistant cameraman Peter Romano set up for a tunnel shot. As the boom camera moved forward or backward through the tunnels, stagehands either removed or replaced the enclosing upper panels.



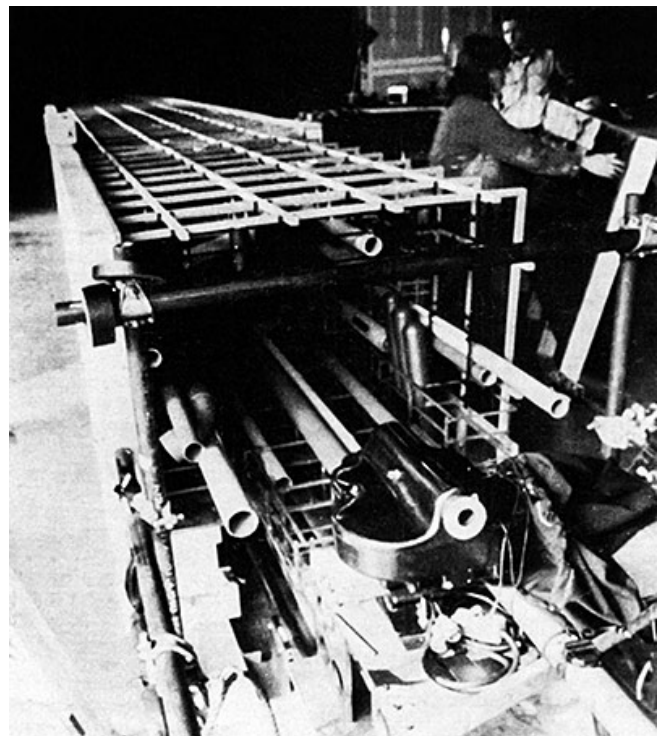
Steve Gawley at work on the last stretch of tunnel leading into the reactor core. By the time the project was completed, Gawley and his crew had produced about a hundred yards of tunnel — all detailed and lit.

We did a few shots at 24 frames per second, but most of the sequence was done at 72 frames per second. As a result, in order to hold depth of field, we had to have an incredible amount of light. To keep from burning up the puppet, we shot with a cool mirror pitched over the set — one which reflects infrared. By shining our lights *through* that mirror, we were able to reflect out most of the heat. We also had a slight fan on all the time. In addition to our primary camera, we had a video system looking through the lens so that Phil and Tom could watch a monitor and see what they were doing. We had quite a lot of trouble getting an image, though, because we were using high-speed film stock, and by the time you've stopped down using the high-speed stock, you hardly have any light. Unfortunately, these video systems are not made to work in low light levels, so that was something we had to fight all the time.

Since we'd already shot two sets of videomatics on the sequence, we really had it timed down to exactly what we needed. Most of the shots were short — the longest, I think, was about four seconds — but we shot a lot of extra length on them, just to give George room to play around. And as it turned out, the sequence *did* end up being lengthened a bit. The same thing happened with the bike chase. On that, we found that by the time we got camouflaged rocket bikes racing through a forest at very high speed, it was pretty hard to see what was going on in the kind of quick cuts we had in our videomatic. Fortunately, we shot everything about fifty percent longer than it was supposed to be, and so George was able to lengthen all those shots a little bit and make everything easier to follow.



Storyboard artist Nilo Rodis-Jamero watches ILM video technicians set up for a videomatic shot on an unfinished tunnel section. As was later used in the film, parallel mirrors mounted on the sides made the tunnel infrastructures appear to repeat themselves off into infinity.

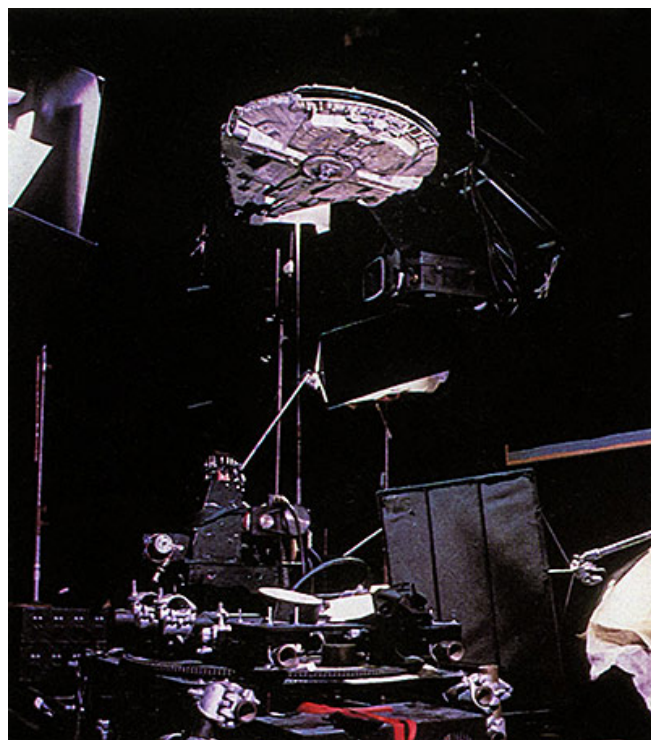


A special tunnel section with a high-speed track was sequenced with pyrotechnics for the scenes in which the

Millennium Falcon attempts to outrun the destructive fireball.

The bike chase is finished. All the comps are in on that. Ironically, the very first shot that we put through optical — a POV racing through the trees as Leia's rocket bike blows up — was the last shot to come back. We also have a log-rolling scene in the walker sequence that wound up being one of the last ones out. That was a difficult and time-consuming shot, right from the start. In the film, the ewoks have built a pile of logs at the top of a hill and as one of the walkers is climbing up the slope, they unleash the logs and the walker does kind of a dance on top of them — like walking on logs on water, almost — and then falls over. To get the plate for that, Paul Huston and Barbara Gallucci and some others in the model shop built a pretty good-size miniature set — about twelve feet by eighteen feet — with trees probably six to eight inches across. The set itself wasn't built to the scale of our go-motion walkers — which were about fifteen inches tall — but to the scale of a larger three-foot-tall walker we made for some high-speed shots. Of course, since we were bluescreening the go-motion walker, the scale didn't make any difference. Anyway, the set had a hill on the right-hand side of the frame and then sloped off. There were a lot of miniature trees, and then behind it all we had a big painted background that the matte department did.

It was another situation where we had to fight overdesigning the shot. When you're doing something like that, you can't help but get an idea of how the shot should be. And the natural tendency is to try and work all that in. When in fact, if you're actually going out and shooting a movie, you might only be able to get half of what you want. The light might not be right; some props you wanted may not have been delivered on time, a tree may have fallen over where you didn't expect it. That's all part of movie-making; and one of the things I was consciously trying to do was give our shots a kind of



The Millennium Falcon, mounted on a motion control model mover which affords it several different axes of movement. This two-foot miniature was used primarily in scenes where the ship had to significantly alter its image size as it passed through the frame.



“rough” look so they would fit in better with the rest of the film.

Richard D. Hund with the lenses, four-foot Phil Smith discuss picking up for his extra detail whenever the ship appeared in closeup.

We had some conceptual problems at the beginning.

Miniature logs would have to be rolled down the hill

as part of the plate element — which would be shot high-speed — and we couldn’t decide exactly how they should interact with the go-motion walker that would be added later. George thought they should hit a leg of the walker — which, of course, wasn’t actually there when we shot the logs — and he came up with the idea of having little pegs sticking up through the table, so that when the logs rolled down they’d actually hit something. Then we’d just have to make sure that the walker foot hit that same point at just the right moment. George wanted the shot to go on for a long time; and the way it was set up, it ran for about eight seconds — some of which has since been cut back. But it was a very complex programming job — lining everything up — and Phil must have spent the better part of a couple weeks on it. We’d keep shooting RARs, and George would look at them and say, “Well, let’s just do it a little more like this.” He was pretty picky about that shot. He wanted the walker to have real personality; and Phil had to work out a way to give the situation a sense of comedy, and yet still be believable.

The follow-on to that was a high-speed shot with the larger-scale walker as it falls over in closeup and you sort of pan over with it as it crashes to the ground. We used the same miniature set on that one, and we had a lot of trouble with depth of Held. That’s always a problem with miniatures, but in this case we couldn’t even use split diopters or anything like that to bring the foreground into focus, because there were branches and ferns all over the place and everything crossed in front of everything else. So we ended up using Eastman’s new high-speed stock and forcing perspective on everything.

That new stock ended up being incredibly useful. It made a huge difference with the Rancor creature and the other highspeed stuff we had. We also used it quite a bit in our plate photography, when we were shooting at six-thirty or seven at night with the lens all the way open. We couldn’t have possibly done that on 5247 or any other stock. We found out, though, that in duping it apparently picks up a lot of contrast — which we didn’t know before. We did a test with it, but we never saw that problem because the test was done in an overcast situation, which is what the weather forecasters were predicting for the time we’d be up in the woods. So we did our test, duped it, and ran it through the interpositive-internegative release print stage, and everything was fine. But when we actually got up there, we had two days of overcast and all the rest were bright sunlight — very contrasty. And then when that got duped, it ended up picking up a lot *more* contrast. So it’s not quite the same as 5247, but it definitely has its place.

One of the last things I worked on was the end sequence — the big victory celebration where Luke is in the forest and we pan up to X-wings flying through the sky at night and fireworks going off. Then there were two other shots — the same sort of thing — where we tilt down to the forest. Ken’s guys ended up shooting the ships for that, and I went out and shot a bunch of fireworks one night near Golden Gate Field, which is a racetrack up here. We spent a night out there with Thaine Morris and Dave Pier and shot off all kinds of skyrockets and things. It was quite an experience — getting an exposure on those things and then preplotting what flight path you wanted the rockets to blow up in. It was like the Fourth of July in February; and I’ll bet we had all of Alameda County and

Berkeley County out watching us. That footage eventually ended up being background plates that were then put into — in some cases real trees, but mostly into a matte painting of trees and skies.

Another thing we did fairly late in the show was the radar dish explosion. That was a shot George came up with which was a view looking out over a valley, across pine trees and redwoods for miles on end, off into the distance. Then, in the middle of all this is a huge radar dish — about a quarter of a mile across or so — pointing up in the air. And it blows up — which turned out to be one of the hardest shots in the film to figure out how to do realistically. If we matted the explosion in, we'd get that matted explosion look which always looks phony. So we had to explode some kind of a miniature and shoot it at high-speed. At one point, we considered getting one of the large dishes you can buy now from television stations and put in your backyard. For a couple thousand dollars — and some modifications from the model shop — we could have something like the real thing, and just redesign the shot looking up at it.

What we ended up doing, though, was much simpler. We went back to the kind of thing Willis O'Brien used to do, and we took a huge canvas backing that we'd used behind one of the walker setups on *Empire*. It was sky and snowscape — about thirty feet long — and we put it in the very back of our setup. Then we had some cutouts made out of masonite with trees painted on, and we put those in front of the backing to cover up the snow. So now there were trees and sky back there. Above seven feet in front of that we put our model dish — which was about three feet across — and then another seven feet in front of *that*, Chris Evans did a glass painting. Between the glass painting and the model we placed a scrim that was lit with blue light to just knock everything back into the distance. Around the base of the dish we put some little industrial trees that are made for architectural models. They're only about three inches high, so the scale was great; and they're made out of steel wool and burn very well. For the dish itself, I didn't want a prefabricated look — which a lot of the stuff we do here tends to have, since we use a lot of molded plastics. As a result, they tend to have the same tensile strength all over. So Lorne Peterson made it the way a real thing would be built — with struts and fabric materials and things, so that when it was blown up it would look like it was really made out of different materials. Then we put a lot of light on it and shot it with the high-speed stock at 300 frames per second



Luke Skywalker and Darth Vader engage in a climactic lightsaber duel. During principal photography, actors Mark Hamill and David Prowse used mockup swords with solid shafts — or, in some cases, wielded only the hilt. In postproduction, Visual Concept Engineering — under supervision of ILM alumnus Peter Kuran — painstakingly rotoscoped each frame and produced the glowing shafts which characterize the traditional Jedi sidearm. In all, 102 lightsaber shots were produced.



— and it all worked out. The final shot lasts about sixty frames, and we got it in one take. It was real quick. From concept to completed shot took about three or four days, not even working full-time. And it was a finished shot, right in the camera.

In a sequence hand-animated by Terry Windelt, Luke is rendered helpless as the Emperor unleashes the full fury of his evil powers.

These kinds of straightforward, simple approaches are always very satisfying. During the ground battle, for instance, the ewoks are throwing rocks at the walkers; and we had this one shot where a walker gets hit in the head by five or six rocks. Instead of doing that with go-motion rocks — which had been suggested — what we did was put a thick piece of plexiglass in front of our blue screen and throw *real* rocks at it. Then we lined that up with the walker. We just saw the final on that yesterday and it came out very realistic. If we'd tried to imagine what it would be like and then done it with motion control or something, it would never have been the same. This way, they hit and they pitch and they do all the things real rocks would actually do — because they *are* real rocks. Often it's the obvious that gets overlooked.

Right now, I'm just kind of following my shots through, and optical is racing to get the composites out. Originally, everything was supposed to be done by April 2nd, but I think now it's been pushed back to April 8th. The sooner it's done, though, the more time George has to work it — and for his final fine-tuning, he needs to be able to see the whole thing put together. Fortunately, I think we did a pretty good job here on anticipating the scope of the problems and gearing up for them. We built a big new blue screen on our stage, and another eighteen-foot blue screen on the tracking stage. Before, we had two printers; now we have four — and they're all going full-bore. If we hadn't anticipated our needs, in those and other areas, we'd be in a pretty sorrowful state right about now. But by gearing up in advance, we've allowed George the time to make changes and still hopefully get everything done.

For me, *Jedi* has been the most rewarding show I've worked on. I had about 240 shots in all, with three visually different and difficult sequences — and yet, I found *Empire* a lot harder and more painful to do. I guess maybe by the time *Jedi* came along, everyone at ILM was working with more experience and with the aura of the third *Star Wars* in the air. As long as we're able to keep things looking fresh and different, and continue to maintain the kind of dialogue and understanding that comes from working with the same talented people year after year, ILM can't help but continue to be a really great place to make movies.

4 April 1983 — KEN RALSTON

All the elements are done. Among the last things to be finished were the laser effects for the big throne room sequence at the end where the Emperor does a half-gainer down this big tube. When he hits the bottom, the thing blows up and this burst of light energy comes flying up toward the camera. It looks a lot like the stuff in *Poltergeist*, to be honest — it's nothing new. There's only so much you can do with lasers, and it all looks pretty much alike. That was done quite quickly — mainly because we were out of time — and it's just an extra element added to all the other stuff in the sequence.

As far as model photography goes, I tried something a little bit different for the X-wings flying through the sky as the fireworks are going off. We needed about a dozen and a half ships for those

shots, and they were all supposed to be quite small, so I took a commercially available model kit that has an inch-wide X-wing in it and I used one of those. We rigged the ship against black, since it's a night sky and we were going to burn the elements in anyway. We did them in two passes — one a basic light pass and the other an engine pass. For that, I just painted the engines with fluorescent paint and lit the model real hot so it actually looked like the engines were glowing. That turned out to be a lot simpler than rigging some kind of little light inside. On one of the shots, we tried putting a lot of ships on one piece of film — which would have made it easier for optical — but the chances of bumping one of the other ships during the light pass was too scary, so I decided to do them one at a time. The effect turned out pretty good, I thought, but later on they had to change the angles on some of the ships, so a lot of them are now just flat art done by the animation department.

Animation still has to redo a few things, but not too many. Hardly anyone is around here anymore — except for optical. Even animation has been cut back by about fifty percent. So it's almost over with. Within the next couple of days, optical has to have a composite done on every shot — even if it's not right. Apparently, there are going to be a few pre-screenings — public sneak preview type things. Nobody around here knows where or when — otherwise we'd probably all be there — but George understandably wants most of the shots cut in so he can see what the reaction is. All of my shots will be done for the sneak preview, except for one in the space battle that has about eighty elements — lots of TIE-ships flying through.

Optical is going crazy trying to meet the pre-screening deadline; but once that's out of the way, they should have another week or so to get the really finished shots done for all the 70mm prints that have to start being made. In fact, right now they're doing the reels that don't have any effects in them — or very little. As for me, I won't be completely at ease until the film has opened up all over. After the *Empire* premiere, and after the wrap party, I took off and went down to L.A. — and then got a call saying George wanted to add three or four more shots. So you never know.

Every project seems tough when you're going through it, but I can't help but feel that any movie after this one will seem like a breeze. It's been so big that I'm surprised everyone has been able to keep under control. Most of us are still on speaking terms, even. Everybody here realizes that this is the last of the trilogy. And who knows? It could be the last of them all. So there's been a nice kind of competitiveness on this film — nothing negative or aggressive. Quite the contrary, in fact. It's just that everybody wants to work at some of the best shots in the show, and everyone's striving for excellence. George has really been working himself to death on this film. It's a very difficult experience to go through just once, and he's gone through it three different times. As for the rest of us — especially Dennis and Richard and those of us who've been in on this *Star Wars* thing from the beginning — it's been a really neat experience to see the unusual impact these films have had. They've truly become part of our culture. *Jedi* could easily be the best of the bunch. In any event, I'm sure people will think it's a great show. If they don't, we'll all just kill ourselves.

Ken Ralston, and other members of the Lucasfilm team, may rest assured that no such dire measures will be necessary. On May 25, 1983 — six years to the day from the original Star Wars premiere — Return of the Jedi opened to the most frenzied box-office response in motion picture history — a staggering \$45 million in gross receipts for its first week in release. By summer's end, the latest Star Wars chapter should easily have joined

the earlier two in the exalted ranks of filmdom's all-time Top Five. As for Industrial Light and Magic, the celebrated effects facility has again been split into two separate units, with Dennis Muren taking charge of the effects work on Indiana Jones and the Temple of Doom, and Ken Ralston reprising as effects supervisor on the third feature installment of the Star Trek series. Richard Edlund, meanwhile, after eight years with the Lucas organization, has left ILM and returned to Los Angeles where he is currently involved in discussions on several as yet unannounced effects productions.

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